

The Blast Furnace *and* Steel Plant

Vol. XII

PITTSBURGH, PA., APRIL, 1924

No. 4

China's Second Rolling Mill

Purely Chinese Control Will Operate Modern Motor-Driven Units

By H. C. FLEMING*

THE second rolling mill to be constructed in China, and the only one to be in operation, commenced work at Pootung, opposite the Kiangnan dock yard near Shanghai on the first of January, and will have a monthly output of approximately 1200 tons of bars, billets, T-s, rods, cross-bars, bars for reinforced concrete, and light rails up to 26 pounds in weight. The works comprise two Siemens-Martins steel furnaces and a rolling mill, the entire equipment being of German manufacture, from Westphalia, and supplied by the Siemens-Rheinlbe-Schuckert-Union through their agents in China, the Siemens China Company. The new plant will cost, it is estimated, approximately Tls. 900,000 and will be the property of a purely Chinese concern, with a concession from the Ministry of Communications. The managing director of the plant will be Mr. Loh Pa-hong, and the consulting and directing engineers will be Messrs. Bucher and Kocher, of the firm of Siemens China Company.

The building of the plant comes as the result of a move by local Chinese iron and steel merchants who are interested financially, with the intention of avoiding the occasional shortages of steel products in Shanghai, with attendant high prices. Shortages often occur in special grades of steel or in special shapes or forms, which contractors or merchants must have immediately. The result is that until telegraphic orders can be filled and shipped from Hamburg, from Liverpool, or from the Pacific Coast of the United States, local merchants are at the mercy of a bull market, and scarcity prices. With the new plant it is expected that such shortages can be filled on short order and immediate delivery made.

The new plant, which is the property of the Wouching Iron and Steel Company, Limited, will operate two Siemens-Martins ovens producing high grade steel, the smaller with a capacity of 12 tons per day of seven hours, and the larger with a capacity of 36 tons per day of 10 hours. It is anticipated that the smallness of these ovens, though making necessary a larger proportionate consumption of coke, will make possible the production of a better grade of steel, and will be easier to handle. The monthly capacity of the two furnaces will be about 1300 tons of high-grade steel.

For these furnaces either a mixture of pig-iron with scrap iron, or a mixture of oxydic iron ore and molten pig iron will be used. The company has its own supplies of ore in Chekiang, and is connected with the

Ihua Iron Mining Company in Wuhu. It also has blast furnaces capable of turning out approximately 1300 tons of pig iron a month, though these have not been firing recently on account of the low price of pig. But the use of scrap iron in the ovens will make the ovens and the rolling mill independent of its own blast furnaces, and in rush times, with the use of several shifts, capable of greatly increasing its output.

Construction on the plant began on April 1, 1923, but the delivery of the machinery was held up in the fall on account of difficulties with the French authorities in the occupation area. The plant has a considerable river front, from which the production will be shipped to various parts of China as well as the local market. It occupies an area of about 80 mow, but with extensions resulting from the construction of a new dyke by the Conservancy Board and a pier by the company this will be enlarged by another 25 mow.

It is estimated that the local market requirements of steel are about 60,000 to 80,000 tons, and if the plant turns out 10,000 tons only a year, it can find a ready sale for it locally. Besides the production of rolled steel, the plant is equipped to make big cast steel parts for ships and large cast steel pipes, from part of the output of the Martin furnaces.

The electric power by which the rolling mill is to be operated, 1,000 kilowatts, will be supplied by the Chinese Electric Power Company of Nantow.

The new plant is the outcome of a number of years of development on the part of the Wou-ching Iron & Steel Company, which put its first plant up in 1917, at a cost of only Tls. 80,000, a blast furnace equipped to turn out only 350 tons of pig iron per month. This, however, was sold at Tls. 250 per ton, and the original cost of the plant was paid off in the short space of three months. The promoter was Mr. Lo Pah-hong.

This success induced the company to put up a second and much larger furnace with a capacity of 1,000 tons monthly. Both of these furnaces were constructed entirely out of local material and machinery made locally, by Chinese engineers but under the direction of German engineers. The contractor for the construction of the second furnace was Li Koh-king; the drafting engineer Mr. Kocher of Siemens China Company, and the construction was in charge of Dr. M. Bruecher, technical manager of Siemens China Company and representative of the Rheinlbe-Union. Mr. E. Oster remained in charge of the blast furnaces.

Before the second furnaces were ready, however, the war ended, and the price of pig iron dropped to

(Continued on Page 190)

*American Consulate, Shanghai, China.

SHEET AND TIN PLATE

Pair Heating

Conclusion of Description of New Design Heating Furnace—
Remarkable Savings Shown by Carefully Recorded
Tests—Heating Costs Analyzed

By WILLIAM C. BUELL, JR.*

PART III

In the preceding issues Table II contained itemized costs of heating a ton of bolts. The comparison is valuable and is continued in Table IV.

This data might be tabulated as follows for comparative purposes:

TABLE IV—FUEL COST—CONTINUOUS BOLT MAKING

(Cost per Ton of Metal Heated)

Fuel Oil*	\$1.50
Natural Gas*	1.80
Pulverized Coal	1.60
Semi-producer recuperative furnace, 231 lb. coal rate	.623
Same, 151 lb. coal rate	.364

*Firing cost not included.

Fuel Cost — Pair Heating.

For the purposes of comparative analysis it will next be necessary to draw some conclusions as to the present cost of heating sheet bars. Figures from many plants, available for comparison, show such a wide divergence in all methods of firing coal that it will be necessary to work within considerable limits. A large plant, operating with stokers and keeping accurate records gives 325 pounds of coal per ton of sheet bars as its average, and this figure will be taken as the maximum although probably far from that. Unofficial records from small plants, over short periods of time have been given as low as 180 pounds of coal per ton of steel. This figure will be conceded to be a fair minimum and will be used as such. Investigation of coal handling and firing in furnaces from quite a large number of plants would indicate that \$1.40 per ton was about the average and if the cost of coal on the siding is taken as \$3.00, a total coal cost of \$4.40 is the result.

One pound of steel will require 270 Btu. to raise its temperature from cold to 1700 deg. F. and consequently 540,000 Btu. is necessary to raise one ton through this range. In the tests previously described, the calorific value of the coal was 12,800 Btu. per pound and this figure will be used in the following calculations.

*Consulting Engineer, Pittsburgh, Pa.

TABLE V — FUEL COST — PAIR HEATING

(Cost per Ton of Metal Heated)

Coal Cost \$4.40 per Ton

Lbs. Coal per Ton of Steel	
325	\$0.72
300	.65
275	.60
250	.55
225	.49
200	.43
175	.39

Comparative Efficiency.

The following table will give the efficiency (thermal) based on the above coal rate and the previous data:

TABLE VI — EFFICIENCY — PAIR HEATING

Lbs. Coal for Ton of Steel	
325 — $540,000/325 \times 12,800 =$	13.0%
300 — $13 \times 325 / 300 =$	14.4
275 — $13 \times 325 / 275 =$	15.8
250 — $13 \times 325 / 250 =$	17.3
225 — $13 \times 325 / 225 =$	19.3
200 — $13 \times 325 / 200 =$	21.6
175 — $13 \times 325 / 175 =$	24.7

The above values compare with a gross efficiency for the semi-producer recuperative furnace of 22.9 per cent for four-day operation, 32.4 per cent for the best day; and with the net figures of 28.9 per cent and 40.0 per cent respectively from Table II. In making the comparison it should be born in mind that the metal temperature is about 200 deg. F. greater for the bolt bars than is usual heating practice on pairs.

It can be assumed with safety that the mean of the gross (27.7 per cent) and the net (34.5 per cent) will represent the probable and the possible operation and ignoring the increased thermal efficiency contingent upon the lower temperature in heating pairs, it will be found that with proper substitutions the coal for pair heating with the improved method will be:

TABLE VII — COAL REQUIRED — PAIR HEATING
Semi-Producer Recuperative Furnace

	Per Cent Efficiency	Lbs./Ton
Good practice	27.7	156
Best practice	34.5	125
Possible	40.4	108

By the substitution of the proper figures of pounds of coal above, and the cost figures Table III we will arrive at the following:

TABLE VIII — FIRING COST—PAIR HEATING
(Cost per Ton of Metal Heated)

Semi-Producer Recuperative Furnace			
Good practice	0.623 x 156 / 231 =	\$0.42	
Best practice	0.623 x 125 / 231 =	.34	
Possible	0.623 x 108 / 231 =	.29	

In none of the foregoing comparisons has mention been made of the furnace upkeep cost. This item will make a most favorable showing in favor of the new type. In a year's experience the brickwork of the furnace is in perfect shape and it was constructed entirely with Pennsylvania second and third grade brick.

The Improved Method.

The method can be applied to any furnaces having the common bottoms or continuous methods, and the entire structure will occupy less floor space than a hand or stoker fired continuous furnace.

There are six factors entering into the design and operation of this furnace that have a great bearing on the splendid results secured. They are:

- (a) The two stage method of burning the fuel.
- (b) The use of preheated air.

(c) The ease and convenience by which coal, air and steam quantities are controlled.

(d) The ease with which furnace temperature and atmosphere is controlled.

(e) The recuperator.

(f) The suspended arch construction which permits cross sectional elevation of the furnace chamber to be designed to maintain the furnace gases within the range of speeds conducive to the maximum heat transfer.

By the two stage method of burning the fuel, all the good points of producer gas firing are retained and the undesirable factors eliminated. Producer gas seems to give the metal a more thorough "soak" than any other fuel in an equal time.

The use of preheated air improves furnace operation in two major points. The first is that of materially increasing the speed of the combustion reaction and the second has the effect of increasing the flame temperature of the fuel. Especially in the use of coal, air at atmospheric temperatures tends to appreciably reduce the speed of combustion by withdrawing a considerable amount of the sensible heat in the fuel bed, and by its cooling action preventing complete combustion and forming smoke. The use of highly preheated air, as with this system, causes about one-half of the total air to enter the combustion reaction at temperatures only slightly below the kindling temperature

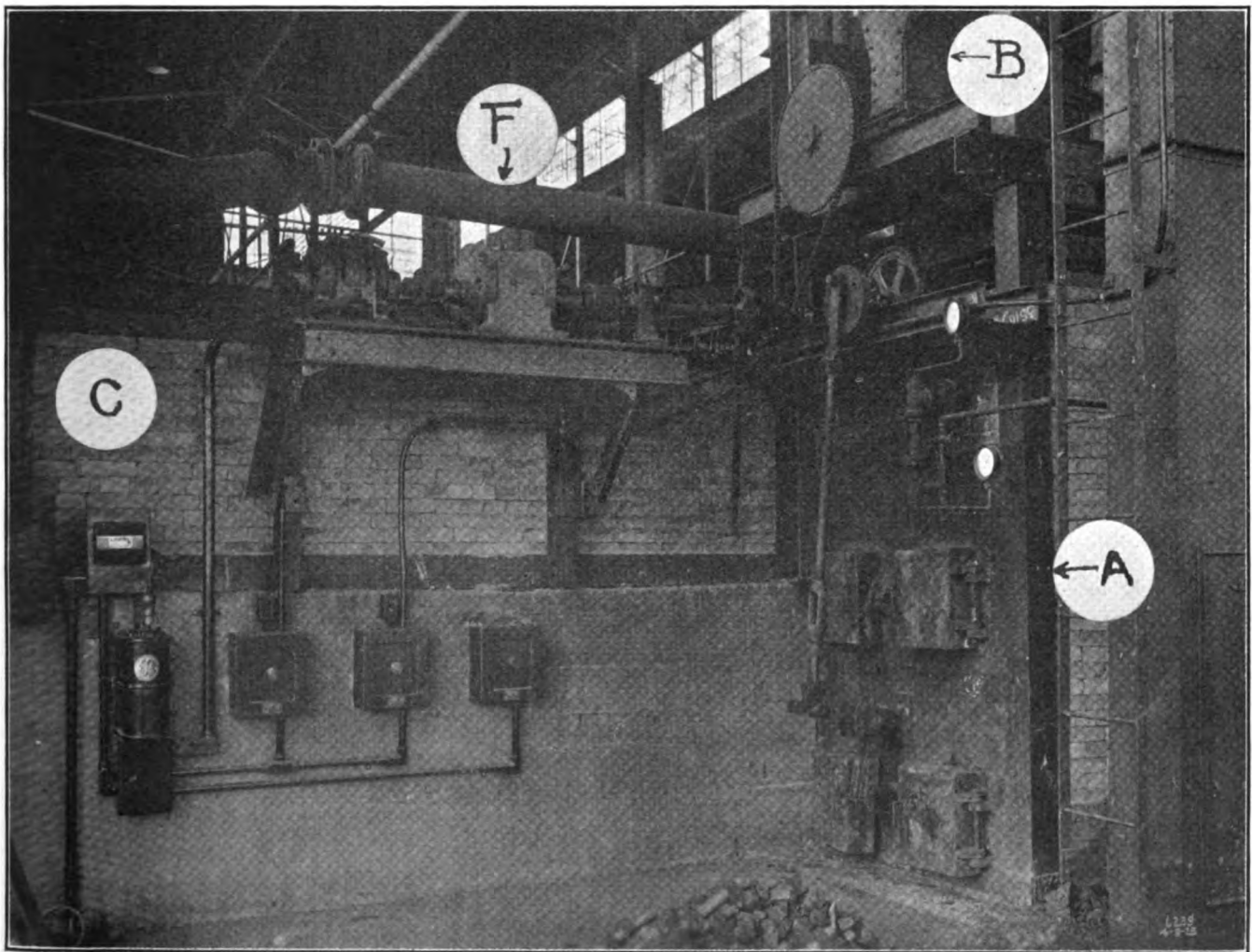


FIG. 3—Another view of producer furnace showing accessibility of controls, flow-meters, etc.

of carbon thus causing and accelerating the combustion of those components that would usually pass off as smoke.

The second is the increase of flame temperature which has the effect of increasing the calorific value of the fuel itself in an almost direct ratio of the calorific value of the fuel to the Btu. returned in the air.

In operation, three controls are used by and are convenient to the operator. They are the coal feed clutch, which when engaged causes the feed of the fuel; a steam valve by which the quantity of steam and proportionally the air introduced under the grate is adjusted, and which carries the coal, air and steam through the gasification reaction of $C + O_2 = CO_2$ and the secondary reaction of $3C + 2CO_2 + H_2O = 5CO + H_2$.

The air coming from the recuperator and which completes the reaction of $5CO + H_2 + 3O_2 = 5CO_2 + H_2O$ is controlled by means of a slide gate on the cold side of the system.

Experience has shown that with the coal feed at one of the selective speeds, steam at a given pressure and the hot blast at a given pressure, temperature and atmospheric conditions can be maintained within close limits. The temperature range will fall well within 50 deg. F. During the tests previously mentioned, over 200 furnace gas analyses were made and these gave the CO_2 component well above 16.5 per cent, and on a few occasions samples were taken that gave the ultimate.

The method of recuperator construction has previously been touched upon. In this device conditions for a high heat transfer are nearly ideal. The air passes through without the great resistance encountered when changes of flow direction are made. The design gives true countercurrent action and repairs when necessary may be made conveniently.

The pipe elements are of commercial steel pipe, and it was the thought in installing these, that they would last long enough to permit sufficient figures to be taken, to form the basis for a study of its value in the system. After 10 months' service the original pipes are still in service and from appearances will last for many more months. In service the waste gases enter the recuperator up to 1850 deg. F. and the air is heated to about 900 deg. F. indicating a metal temperature of perhaps 1400 deg. F. at the base. It is thought that the long life of the pipes, comes from the high air velocities, especial attention having been given this point in design. It should be mentioned that pipes treated to prevent oxidation at high temperature, have long been on the ground, ready to be used upon the failure of the steel pipes.

The suspended arch is a considerable help to even heating and increased economies. Quite often after a furnace is in service it is found desirable to change the conformation to produce a change in heating conditions and certain types of the suspended arch lend themselves particularly well to this purpose.

Again it may be desirable to develop an arch to the long axis of the furnace and in part to develop it also on the short axis. The suspended arch permits this to be accomplished.

Conclusion.

A final comparison of costs gives: Heating cost, present practice, and at a rate of from 175 to 325 pounds of coal per ton of metal, 0.39c to 0.72c. Im-

provement by use of semi-producer recuperative type; coal rate 108 to 156 pounds per ton of metal at a firing cost of 0.29c to 0.42c. This improvement will represent an average reduction in firing cost of 0.20c per ton heated and a saving of from 25 per cent to 42 per cent.

While the item of fuel saving is in itself important, it is the writer's belief that a much greater indirect saving will come through the more nearly automatic temperature and atmospheric control, the ease with which any given condition once established may be later duplicated, the virtual elimination of all manual stoking, the reduction in the cost of furnace upkeep, and the greater satisfaction of the rollers in the quality of the metal.

China's Second Rolling Mill

(Continued from Page 187)

Tls. 40 per ton. Foundry iron was made, but the blast furnaces could not compete with the Nanyang Iron Works and imported material, and the plant did not operate. The smaller blast furnace operated until 1923, when it stopped, the local market being flooded with 100,000 tons of pig iron.

The original capital of the company, Tls. 80,000, was increased in 1918 to Tls. 350,000 which was raised in 1921 to Tls. 1,000,000. Of this to date only 75 per cent has been paid up, but as the cost of the new plant is to be Tls. 900,000 the rest of the capital will probably shortly be called for, and when the plant is paid for, the firm will have a working capital of Tls. 100,000. It is hoped that with the experience gained and the staff built up with this plant, expansion on a larger scale may be possible later on. The administration of the plant will be Chinese, but the manager and the assistant manager will be German. Baron Von Ungern-Sternberg, now in Shanghai, will be the managing director.

Changes in Blaw-Knox Organization

Robert T. Harris, who has been located at the New York office, has been transferred to Baltimore as district sales manager for all the products of the Blaw-Knox Company.

Walter H. Duncan, formerly field engineer for John F. Casey Company, contractors, has joined the sales staff of the Road Equipment Department of Blaw-Knox Company.

William F. Glasser, formerly engineer in the Heavy Forms Department of the Blaw-Knox Company, has been promoted to Assistant Chief Engineer of the department.

Charles K. Wehn, formerly located at the company's Chicago office, has been transferred to the Pittsburgh office, as district manager of the Standard Steel Building Department at Pittsburgh.

R. D. Spradling, who has been located at the Baltimore office, has been made district manager of the Standard Building Department at Chicago.

Dan W. Healy remains at the New York office in the capacity of district sales manager of the Standard Building Department in New York.

THE SAFETY CRUSADE

Elimination of Accidents

Safety in Material Handling Mechanically Deserves Greater Amplification

THE use of material handling equipment, whether for packages of definite dimensions or for bulk products, in its rapid development for industrial uses, has had behind it, primarily, the thought of cost reduction in any of the many ways in which it is achieved.

The warrant for expenditure for improvement; greater speed in production and movement by fluidity of operation, and justification for adoption of these innovations solely on analytical figures, has been the appeal generally, because of the restrictions of expression in figures to tangibles, proven or broadly evident. The final figures of net earnings in a financial report of anticipated benefits holds the spotlight, but the elimination of accidents by conveyors strikes a new note of appeal as strengthening the argument for the employment of this tremendous innovation, the value of which is not fully envisioned without consideration of the human factors involved and the consequent and inevitable result in losses in dollars.

In the realm of material movement the causes of accidents are chiefly as tabulated in the following:

- Physical fatigue
- Mental fatigue
- Lack of safety measures
- Poor working conditions
- Poor lighting conditions
- Inexpertness
- Ignorance
- Carelessness

named generally in order of their importance, the first five being very tangible and have correctives in the adoption of equipment and arrangement to minimize occurrences.

Physical fatigue is frequently due to tasks beyond the capacity of the individual, but when such tasks are brought within the range of work that can only be done with human hands, the individual usually is not overtaxed, and by intelligent direction can be employed to best advantage.

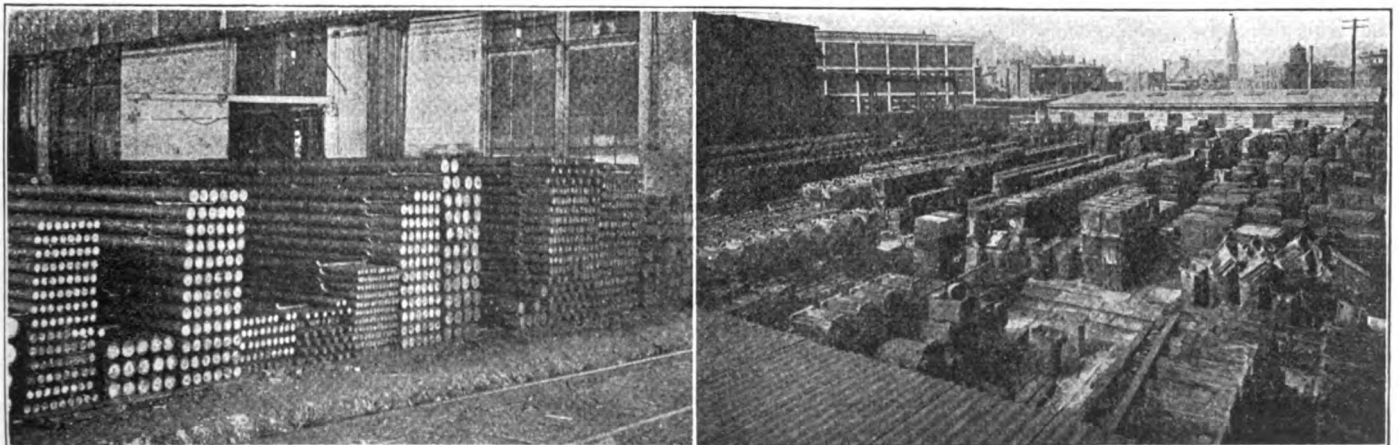
Mental fatigue follows close on the heels of physical fatigue as an effect, though inaptitude, unfitness and unsuitable surroundings and conditions are often causes. Natural instinctive alertness is reduced by fatigue with resultant accidents in inverse ratio.

Poor working conditions blanket a broad variety of conditions, the cataloging of which is unnecessary here, but are vastly improved by the application of mechanical movement and general arrangement to produce the desired results.

Poor lighting conditions are at times really a part of poor working conditions, though frequently arrangement is well planned in all respects with exception of lighting, there being occasions, of course, when full consideration cannot be given to proper lighting because of plant conditions.

Lack of safety measures as referring to arrangements conceived to a partial extent of efficiency, but lacking the supposedly minor points of safety features, has a corrective in additions and refinements specifically applying to local conditions and the completion of the project in detail, encompassing all possibilities within the scope of foresight, irrespective of remoteness or seeming improbability. No scheme is complete without due regard to all safety precautions.

The foregoing is a brief summary of conditions intended to be corrected by the proper employment of conveying equipment.



- Courtesy Westinghouse Electric & Mfg. Company.

Well maintained storage departments. Safety has been well considered in the arrangement.

Inexpertness can be corrected in a measure by a curriculum wherein the individual has duties, restricted in number, or by repetition, sequence, regulation, or standardization, quickly familiarizes himself with the task. The same might be said for the factor of ignorance. Carelessness can be eliminated, partly by training and partly by repetition, naturally forming a habit. A routine prescribed by an arrangement enforcing a methodical procedure, compelling adherence to a preconceived and exact plan of operation.

The following is a discussion of a few subjects that come to mind from past experience. At greater length and with more time for thought on the matter, undoubtedly many more accident possibilities would develop, but the few applications described will, I believe, suggest consideration of material handling, mechanically, broadly visioned from a new and important angle.

There are three principal applications: (1) Raw materials transported, (2) in progress through processes (assemblies), and (3) finished products transported out (accumulation, crating or boxing, storage, and shipping, packing.)

1. Primarily with any labor saving device (and conveyors are of great importance in the realm of these devices) a stabilized product is maintained with a less number of individuals or production is increased without additional labor; in consequence there is a natural reduction in number of individuals engaged through employment of conveyors with corresponding reductions of accidents averaged per individual with former methods of material handling.

2. Conveyors dictate unit movements with greater frequency, a continuous stream. There is no reciprocation of movement as in hand movements by carry or hand trucks. Where necessary for operators to remove or load by hand the smaller unit movement means less weight to manipulate, less chance of falling articles, less fatigue, less of injury due to strain or overexertion. The stream movement or flow, being non-reciprocating, reduces the congestion attendant in aisles or along docks or platforms where movement of individuals in counter directions invite collision. Where conditions permit, transportation is effected overhead by attaching conveyors to ceilings, leaving ample headroom with freeway on floor or in aisles.

3. In process operations, by arrangement of conveyors, machinery, benches, tables, etc., in proper relation to each other, the work to be done by operators can be developed in a manner to produce the greatest ease and efficiency, operators frequently being seated and the work sent in and out of the area automatically, eliminating fatigue. The conveyor sets a nominal pace which has been predetermined by test or time study, the operator is able to concentrate on the task without distraction by interruption, idle periods are reduced to minimum, there are seldom any spasmodic stress periods of overspeeding with consequent frantic efforts to maintain rates, a "rhythmic order" in steady pace is produced, resulting in high production with greatest safety. In movement of raw or finished products, such as loading in or out of cars or boats, there are frequent transportation expediciencies requiring abnormal movement in tonnage or number of units in a period of time, normally overtaxing entrances, exits, or aisles with an otherwise increased number of individuals to handle it. The intelligent use of conveyors in such instances reduces possibili-

ties of accident because operators are required only at source and terminal points, the necessary increase in number of operators is not increased in the proportion required by hand truck movement which involves a double lane of travel the entire distance from source to terminal point. This means a natural reduction of approximately 80 per cent in accidents on average.

4. Conveyors make possible arrangements whereby the best lighting conditions are obtained, the eyesight is not overtaxed, mental strain is eliminated, resulting in a sustained alertness.

5. Automatic conveyor transportation between floors restricts elevators to legitimate use (that of handling such material that does not lend itself to automatic movement) reducing the number of trips on the part of individuals who would be otherwise required to accompany quantities of material for loading or unloading, with consequent reduction in probability of casualties.

6. Through the employment of overhead conveyor transportation, there is a minimum of choke points or areas, with freedom of movement to fire escapes, and less fire hazards.

7. Conveyors displace unskilled workers, many of whom are of the foreign element, often illiterate immigrants, who are generally slow-witted and unresourceful in danger. This type represents a goodly portion of casualties in material handling.

8. In the realm of high temperatures, heat processed parts, hot castings, hot sand, ashes, baking, canning, ceramics, glass products, etc., conveyors are employed, in some cases in a manner to completely isolate operators from exposure to heat, or to handle the products while in a state of high temperature, or until, sufficiently cooled to a safe point of handling. Other applications enable operators to work at safe distances during sustained temperatures. "Small mould" casting in foundries has been developed on circular conveyors to bring moulds directly under a fixed pouring position in uniform time elements, preventing accidental spillage of molten metal.

9. Chemicals, whether transported or used for immersion, offer opportunities in mechanical handling advantageously to the exclusion of many mishaps resulting in human casualties. Dipping tanks for immersion of parts for cleaning, pickling, or coatings are served by overhead conveyors to automatically immerse and remove products without danger to operators. Conveyors serve filling machines delivering spillage of any material of dangerous nature.

10. Conveyors make possible the isolation of operations, such as sandblasting or other work with abrasives, by enclosure of the area of operation, in which the operator can be properly equipped for the work; other workmen on adjacent operations being protected from flying abrasives. This is accomplished by placing the enclosure in the conveyor line, products being delivered into the area and removed automatically.

11. Loading or unloading cargoes of more or less uniform packages, cases, bags, etc., automatically by conveyors reduces possibilities of accident, both in reduction of operators and the danger of falling material in ship's tackle. In loading in, products are deposited selectively on any deck, coming over a through route from any warehouse or process source, or reversed in loading out, deposition being made in advantageous position either way, for safe and easy storage.

(Continued on Page 199)

Weirton's New By-Product Plant

A Further Description of Latest Coke-Oven Development

By C. J. HUNT*

PART II

THE breaker building houses a 12 ft. by 17 ft. Bradford breaker, which breaks the coal up to pass through 1½-in. diameter perforations, refuse, slate, bits of iron, etc., being discharged from the end of the breaker by a chute into a car at the north end of the building, the conveyor chutes and building are arranged for extension to accommodate a second breaker.

Coal after passing through the breakers is conveyed by a 30-in. belt up a 20 deg. incline to a transfer tower and then at right angle for a distance of 85 ft. over a 30-in. belt to the head house over the coal bunkers 110 ft. above yard level. The coal bunker located over the west end of the battery has a capacity of 1,000 tons and is divided into two sections. Provision is made for addition of bunkers to hold 3,000 tons of coal to serve an ultimate of three batteries of ovens and for the installation of a shuttle conveyor at that time to deliver coal from the head of the conveyor to any bin.

All conveyors are designed so that 3,000 tons of coal can be handled in 10 hours by increasing the speed of the belts.

Coal is drawn from the bunkers through four manually operated cut-off gates in the bottom of each bin into a specially designed larry car having four cone shaped hoppers attached at the top of each hopper, just beneath the coal gates is an annular ring 3 ft. 0 in. diameter of adjustable height through which the coal

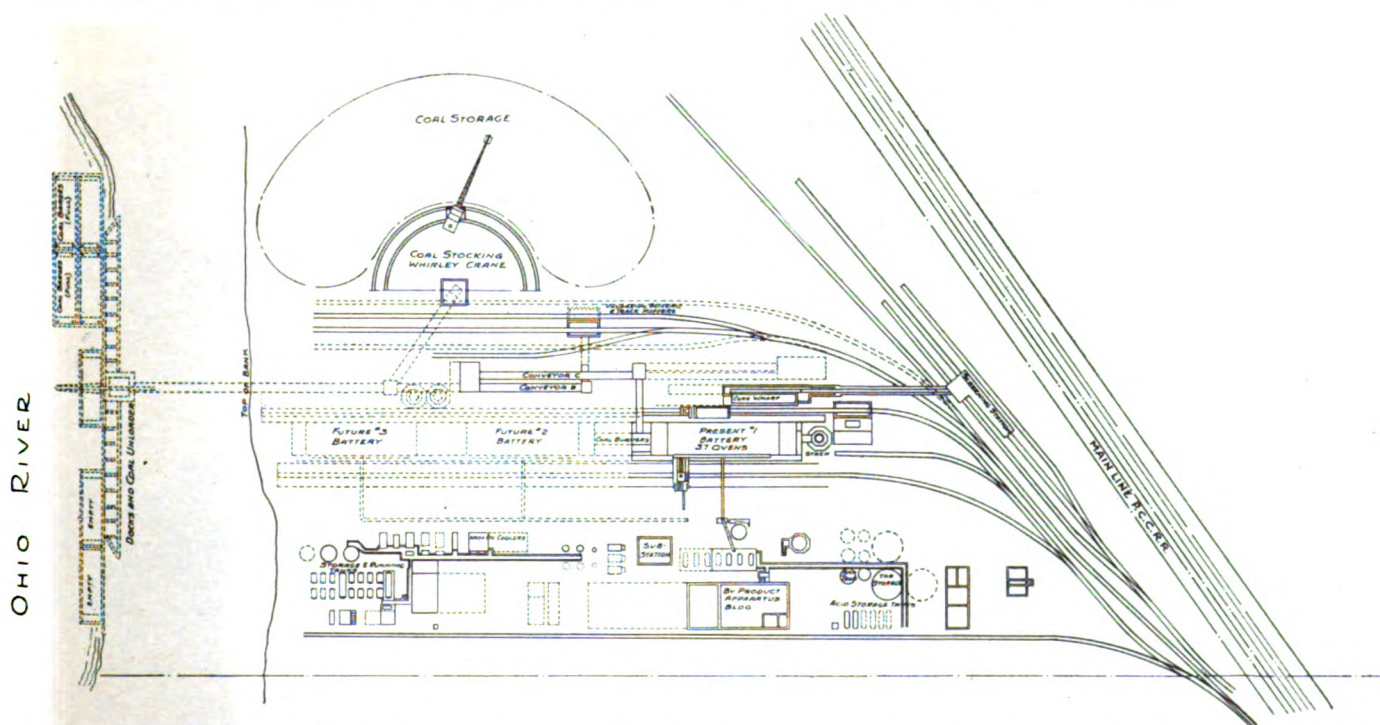
*Chief Engineer, Weirton Steel Company, Weirton, W. Va.

flows into the hopper and into which the coal rises when the hopper is filled, the height of the coal in this ring serving to measure the exact volume of coal in the hopper so that when charged into the oven and levelled, a predetermined space remains between the top of the coal and the top of the oven for the rapid passage of the gases out of the oven chamber. This measuring also successfully serves the requirements in place of the usual scales on the larry car.

Coke Handling.

On completion of the coking period which at present is 11 hours, 46 minutes, the coke is pushed from the oven by the usual type pusher and levelling machine, except that on account of the exceptional height of the oven chambers and consequently the increased height of the regenerators, the sill line being 14 ft. 3 in. yard level, a sturdier, heavier machine was designed due to the height of the run above the rails. The door extractor for the doors on the pusher side is a part of the pusher machine.

During the operation of levelling the coal in the top of the oven, a small amount of coal is withdrawn by the action of the leveller bar—this coal is caught and accumulated in a hopper on the pusher machine and periodically discharged into a hopper beneath yard level adjacent to the coal bin structure, from which it is conveyed by apron conveyor under the bench enclosure to a bucket elevator and elevated to a small bin at the side of the coal bin from which it is returned by the larry car to the ovens.



General plan of the complete coke plant, showing the ideal location between main-line railroad on the right and the Ohio River on the left.

A new heavier type door extractor was designed by the Koppers Company for handling the doors on the coke side of the battery; the door lifting levers, door pulling mechanism and travel along the bench are all motor operated. This machine propels and spots the coke guide in position ready for pushing. There are two quenching cars, one being a spare, of the usual type lined with cast iron plates and having discharge doors operated by air cylinders controlled from the cab of the 20-ton electric quenching locomotive.

The quenching station located at the stack end of the battery consists of a rectangular brick structure 17 ft. 0 in. wide, 50 ft. 0 in. long and 48 ft. high open at the top the area being sufficient to entirely enclose the quenching car. Ample arches at each end allow the car and locomotive to be taken through for repair or replacement and for a standard locomotive or locomotive crane to run in on the quencher track for emergency purposes.

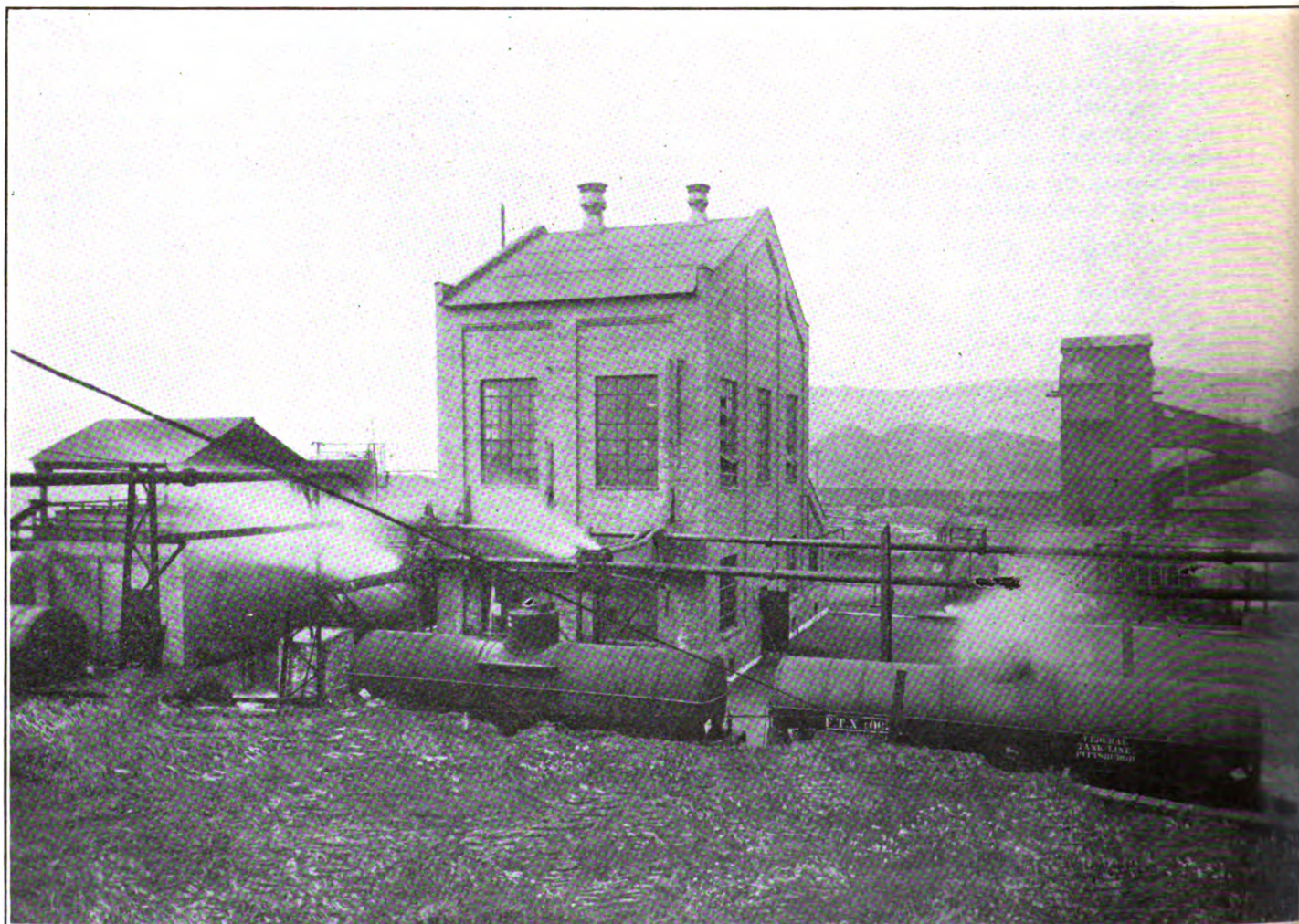
Water for quenching flows by gravity, from a 12,000 gallon tank elevated on a steel structure located alongside into sprinkler pipes supported and located over the car so as to quickly and uniformly quench the hot coke, requiring about 40 seconds.

The water from the quenching car flows to a settling basin which collects small coke washed into it, the water flowing under baffles and through a screen into a clear well, from which it is raised by a 25,000

gallon per hour centrifugal pump against 70 ft. head, into the quenching tank. The motor is float controlled from the water level in the tank, the water lost by evaporation amounting to about 15 per cent is admitted by a float controlled valve into the clear well from the service water line. The feed line to the sprays is 12 in. with a quick opening valve arranged to be operated from the quenching locomotive cab.

To avoid excessive moisture in the coke after quenching has been completed, a 12-in. drain valve in the feed line to the sprinklers is automatically opened on closure of the service valve, which quickly discharges all water remaining in the lines and sprinkler pipes back into the clear well, so that there is no after drip from the sprinklers to be absorbed by the coke, allowing the car to remain in the quenching station until drainage from the coke is completed.

After quenching the coke is discharged onto a coke wharf 84 ft. 5 in. long, inclined at an angle of 26 deg. to the horizontal and covered with special cast iron wearing plates. These plates are laid with their edges flush instead of overlapping to minimize coke breakage and for the same reason the usual type of rotary feeders are omitted, the coke after being spot quenched, where any fire remains, and cooled is discharged direct onto the coke conveyor belt, the flow from the wharf being regulated by cut-off gates composed of $\frac{7}{8}$ -in. square finger bars with handles extend-



General view of plant from by-product side, showing benzol plant at the left,

ed within reach from the operator's platform along the length of the coke wharf.

Coke Screening Station.

The wharf conveyor belt 36 in. wide and 97 ft. 3 in. long center to center of pulleys, discharges onto a 30-in. inclined conveyor 237 ft. centers, which delivers the coke onto a 4-ft. wide revolving grizzly screen with 11 in. diameter discs spaced to give an average of $1\frac{1}{4}$ in. openings, the furnace coke which passes over the grizzly screen is delivered by a curved chute at an angle of 49 deg. onto a 36-in. boom conveyor 96 ft. centers, a portion of this conveyor 57 ft. long is carried on a boom structure hinged at one end and raised or lowered at the delivery end by a 3-ton electric hoist, the weight being partially balanced by counterweights attached to wire cable passing over sheaves and fastening to a structural bail at the boom end, this permits the discharge end of the boom to be lowered into the cars so the coke may be loaded without excessive dropping and breakage; a motor driven drum type car haul moves the cars forward as the loading progresses.

The small coke passing through the rotary grizzly travels over a high speed balanced shaking screen, having a screening surface 4 ft. by 6 ft. with $\frac{3}{4}$ round openings. The breeze passes through this screen and is delivered by a chute to cars on a track

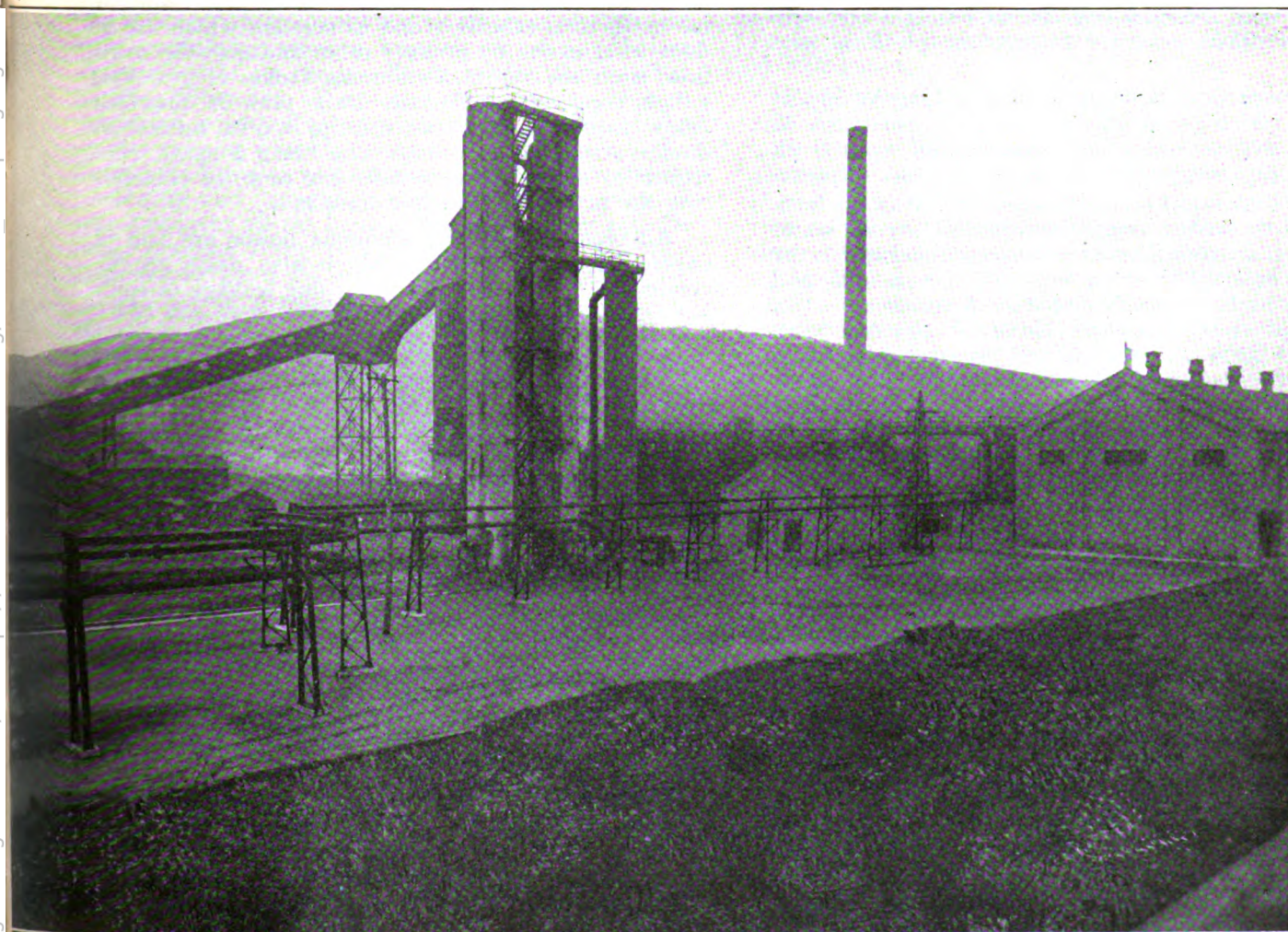
underneath the screening station paralleling the furnace coke track.

The coke passing over the shaking screen falls into an 18-in. conveyor belt and is discharged into a chute arranged to deliver it onto the boom conveyor belt for mixing with the furnace coke or as nut coke to cars on a track alongside the screening station.

The screening equipment and also the head drive for the inclined coke conveyor is housed in a building 34 ft. wide by 30 ft. long with an extension 17 ft. wide by 87 ft. 6 in. long over the furnace coke track and loading boom, at the far end of which is located the motor driven car haul, the control for the conveyors, loading boom hoist and car haul are all centralized over the loading point of the cars under the attention of one operator.

For both the coal and coke handling plants all conveyors below yard level are carried on reinforced concrete beams and slab construction with reinforced concrete posts and above yard level by steel galleries roofed and sheeted with corrugated galvanized steel, the decking under the conveyors being steel plates and the floor alongside the conveyors on both sides being made of reinforced concrete slab construction; all chutes and hoppers subject to excessive wear are composed of or lined with hard cast iron plates or manganese steel.

All troughing and return idlers for belt conveyors



by-product building at the right, with coal handling equipment and battery beyond.

are equipped with roller bearings designed for grease lubrication which has to be replenished only once every four to six months, thereby dispensing with labor for oiling. All conveyor head drives are of heavy design with gearing enclosed in oil tight cast gear cases, high speed bearings ring oiled, with flexible couplings connecting motor armature shafts to the pinion shafts and with alignment couplings between the gear drive and the driven element.

The control for the various conveyor drives is electrically interlocked to start in sequence which will prevent overloading or spillage at any one point by starting the succeeding conveyor first and all conveyors of a system can be stopped simultaneously from push-button stations.

By-Product Plant.

The by-product department is laid out parallel with the battery along the south side of the plant, the benzol department being located west of the by-product buildings adjacent to the river bank. All buildings and equipment have been constructed so that extensions can be made and apparatus added to handle gas from additional batteries of ovens when constructed without delay to existing operations. The present equipment being designed for a capacity of 570,000 cu. ft. of gas per hour and at the benzol plant for the conversion of 200 to 230 gallons of light oil per hour into pure products.

All buildings are of steel frame and buff brick construction with steel window sash and steel doors, with smooth finished concrete or asphalt platform and floors.

The by-product building is 133 feet long by 59 feet wide, 32 feet high to bottom chord of roof truss, 40 feet of the west end being separated off by a brick partition providing storage for ammonium sulphate.

One of the novel features of the layout is the location of all by-product department pumps, service water pumps and air compressors in a room underneath the primary coolers 42 ft. 6 in. long, 19 ft. 0 in. wide and 9 ft. 6 in. high, the walls and roof of which are extra heavy and constructed of reinforced concrete with reinforced beam construction and pilasters under each cooler, this location of pumps being done to facilitate ease of extension to both ends of the by-product building for the addition of apparatus on the east end and additional sulphate storage on the west end; this arrangement also has the advantage of simplifying and shortening the pipe lines to and from the pumps.

Gas from the collecting main at the ovens is drawn through the suction main into a 36-in. downcomer, connecting with the inlet header at the primary coolers. There are three primary coolers of the tubular type, two operating in parallel and one as a spare in which the gas is cooled by contact with the water-cooled tubes from 185 deg. to 70 deg. F. Taylor temperature controlled diaphragm motor valves maintain a necessary uniform temperature of the gas leaving the coolers, by controlling the amount of water flowing through the coolers.

About 90 per cent of the tar is condensed out of the gas by spraying with cool liquor in the collecting main and in passage to the coolers, while the lighter tar and water vapors are condensed in the primary coolers, this water carries with it about 20 per cent of the ammonia in the gas forming what is termed ammonia liquor, the tar and ammonia liquor flowing

into a 20,000 gallon hot drain tank located north of the primary coolers.

There are provided two centrifugal motor driven tar flushing pumps, one held in reserve, located in the pump house having a capacity of 670 gpm., each at 125 ft. head. These pumps circulate tar and ammonia liquor from the hot drain tank to the sprays in the collecting main, this circulating liquor return to the hot drain tank, the amount condensed out of the gas in the mains, which together with the tar and liquor from the primary coolers and tar extractors is pumped by either of two motor driven centrifugal ammonia liquor pumps of 100 gpm. capacity at 75 ft. head, to a separating tank of 45,000 gallons, east of the by-product building, where the tar is separated from the ammonia liquor by difference of specific gravity, the ammonia liquor flowing to the weak liquor storage tank, having a capacity of 70,000 gallons, for further treatment and the tar into a 300,000 gallon storage tank from which it is loaded into tank cars for shipment or for use as fuel at the steel plant.

It may be noted that the hot drain tank is located above yard level with steel platforms level with the top around the pitch traps and strainers, so it can easily be kept clean, instead of a pit below yard level, thus eliminating one of the unsightly places around the coke plant and allowing the tar flushing pumps to operate with suction head and be located above floor level in the pump house, which is only 18 in. below yard level. Therefore to receive the drain from the tar extractors, reheaters and exhausters which are at floor level in the by-product room and also the overflow from the tar and ammonia tanks, etc., a 3000 gallon concrete condensate drain tank is provided below yard level with two 6 x 5¼ x 6 in. horizontal double acting steam pumps, one being a spare, controlled by a float in the condensate tank for transferring the tar, etc., to the hot drain tank.

All pipes for tar and ammonia liquor are laid in covered concrete trenches which also drain to the condensate drain tank, thus returning leakage or spillage from pipes or apparatus.

There are two lines of apparatus in the by-product room, one of which has sufficient capacity to handle all of the gas, the other held in reserve. The exhausters are of the positive type, having a capacity of 11,700 cu. ft. per minute at inlet temperature of 1100 deg. F., designed for a suction of 10 in. of water and a discharge pressure of 2½ to 3½ pounds. They are driven by 16 in. x 22 in., four valve, non-releasing Corliss engines, 135 to 175 rpm., designed to operate against 15 lb. back pressure or atmospheric exhaust.

The gas is drawn from the ovens through the mains and coolers by the exhauster and then driven through rigid three bell type tar extractor where any tar remaining in the gas is taken out, and then on through the by-product apparatus with sufficient pressure to deliver it back to the gas holder and to the ovens at the required pressure.

From the tar extractor the gas passes through a reheater and is preheated by contact with the steam heated tubes to a temperature of approximately 140 deg. F., the gas then enters a 10-ft. diameter lead lined saturator and bubbles up through a 5 per cent solution of sulphuric acid, the ammonia in the gas uniting with the acid and precipitating to the bottom of the saturator which has the shape of an inverted

cone from which it is lifted by an air injector onto a lead lined drain table and acid draining back into the saturator.

The sludge of salt crystals and acid are then whirled in a perforated cylindrical dryer forcing out the remaining acid which flows back into the saturator. After being washed with a small quantity of hot water and whirled until dry, the white soft crystals are scraped from the cylinder by mechanical salt cutters into buggies below the platform on which the drain table and dryers are located, ready for storage or shipment.

The weak ammonia liquor is delivered from the storage tank by one of two motor driven centrifugal pumps, having a capacity of 100 gpm. to the ammonia still where it is mixed with milk of lime and heated by steam driving off the ammonia as a gas which is piped into the gas main just before it enters the saturator and converted into ammonium sulphate.

From the by-product building, the gas is piped into the benzol washers, first passing through the final cooler of the hurdle type, 8 ft. in diameter by 70 ft. high, sprayed with water which cools the gas from 120 deg. to 80 deg. F. and removes the naphthalene, of which very little is encountered with narrow ovens and rapid coking. In order to maintain the gas at a constant temperature, a Taylor controlled valve admits the proper amount of cooling water through the inlet line. The gas then passes in series through the two washers which are 10 feet in diameter by 100 feet high, containing wooden hurdles for about 85 feet of their height, as the gas flows upward through the hurdles, composed of wooden slats set on edge, a petroleum wash oil is sprayed in at the top of the washer running over the entire area and surface of the hurdles from top to bottom, thus the gas is thoroughly broken up and brought in contact with the wash oil which absorbs all the benzol vapors from the gas, the usual practice being to keep the amount of benzol absorbed between $2\frac{1}{2}$ and 3 per cent of the wash oil.

The gas then freed from all by-products flows to the gas holder, less than 35 per cent being required for heating the ovens, the remaining amount of 65 per cent is available as surplus gas which is delivered at 5 lb. pressure to a system of mains supplying gas to the mills, by a positive type rotary gas booster located in the by-product room, having a capacity of 5200 cu. ft. per minute under inlet conditions of 80 deg. F. The booster is driven by a non-releasing Corliss valve engine, duplicate of the engines driving the exhausters. One of the exhausters is also connected with the mill line to serve as a spare for the booster.

The wash oil enriched with the benzol and its homologues is pumped to the wash oil still at the benzol plant, first passing through the vapor to oil heat exchanger where it is heated by benzol vapors and steam from the wash oil still, then to the oil to oil heat exchanger receiving heat from the hot debenzolized wash oil leaving the still. It is then further heated to the required temperature of about 300 deg. F. in two final heaters and enters the wash oil still, 7 ft. in diameter containing 27 trays, in which the heated oil flows down through the still while steam admitted at the bottom travels upward distilling out the benzol vapors. These benzol and water vapors are partially condensed in the upper part of the still and then further condensed in the vapor to oil heat exchanger by

indirect contact with the incoming cold enriched wash oil. The final condensation and cooling is accomplished in a water cooled condenser or light oil cooler 3 ft. 6 in. diameter by 24 ft. 0 in. high—the benzol condensate, termed light oil, is separated from water in the condensate in the light oil separator, 3 ft. 0 in. diameter by 11 ft. 0 in. high, and flows to a 20,000 gallon light oil storage tank.

The wash oil after leaving the oil to oil heat exchanger is finally cooled by the wash oil cooler, consisting of 10 banks of pipe cooled by water flowing over them, and then pumped again to the benzol washer completing a continuous cycle of circulation. There are five wash oil circulating pumps of the positive cycloidal type all iron fitted, each having a capacity of 7,500 gallons per hour, individually driven by 7 x 6 vertical engines at 350 to 450 rpm., one serving as a spare, located in a leanto of the benzol building.

The heat exchangers of this system effect a great saving both in steam necessary for distilling off the light oil and also in water required for cooling the wash oil.

The benzol building is 31 ft. 0 in. long and 51 ft. 0 in. wide and 42 ft. 0 in. high to the bottom chord of the roof, with a pump room leanto 15 ft. 0 in. wide by 31 ft. 0 in. long, and is designed for extension for additional equipment in the future. In addition to the light oil apparatus, the building contains a crude still and a pure still, the still tanks being 9 ft. 0 in. diameter by 13 ft. 9 in. long, each with a working capacity of 7000 gallons.

Light oil which shows a distillation test of 93 per cent at 200 deg. C., is washed by mechanically mixing with 66 deg. Baume sulphuric acid in a 4500 gallon agitator to remove impurities, principally olefines and phenoloides and then agitated with caustic soda solution to neutralize the acid. The purified light oil is then charged in the crude still and about 92 per cent of the benzol and its homologues distilled off by the application of steam in heating coils in the still tank, leaving a residue of naphthalene and wash oil. Two cooling pans, 6 ft. 0 in. wide, 16 ft. 6 in. long and 2 ft. 0 in. deep receive the residue and serve to crystallize out the naphthalene, the wash oil being returned to the wash oil system. The benzol vapors from the still are condensed and cooled by tubular condensers and cooled by tubular condensers and coolers, three fractions are made—crude benzol, crude toluol and crude solvent naphtha.

These crude products are then separately redistilled in the pure still without further treatment, the vapors condensed and cooled making nitration benzol, nitration toluol and nitration zylol—all of these products as finished being absolutely non-corrosive to copper and silver.

A small amount of intermediates remaining in the still fulfill the specifications as 90 per cent benzol.

Steam for the operation of the plant is furnished from the main boiler plant of the Tin Plate Department, where sufficient generating capacity was available without additions, and is conveyed to the benzol and by-product plants by a 6 in. overhead line. The exhauster and booster engines, all steam engines and pumps exhaust into a common exhaust line 8 in. diameter, connecting the by-product and benzol plants, furnishing sufficient exhaust steam for the require-

ments of the reheater and lime still in the by-product plant, and for the wash oil still at the benzol plant.

Provisions are made for returning the excess exhaust steam to the tin mill power station nearby for heating boiler feed water.

The coke plant receives water from the large service main from the river pump house 88 ft. below the plant level, which parallels the south side of the plant. Two motor driven centrifugal pumps—one being in reserve, located in the by-product pump room, having a capacity of 2000 gallons per minute, boost this water from 40 ft. to 125 ft. total head for the general purposes of the plant.

Electric current is supplied from the main plant transmission system to a substation at the coke plant at 6600 volts, 60 cycle and stepped down by three 333 kva. transformers furnishing current at 550 volts for all coal and coke handling and pump motors, also for two 150 kw. direct current motor generators, furnishing power to the oven machinery.

All main transmission lines from the substation to the points of distribution are laid in underground conduits encased in concrete; all exposed lines are laid in pipe conduits and the motors are totally enclosed to exclude all dust; the substation is of brick and concrete construction, 34 ft. wide by 45 ft. long, housing the high tension transformers, lightning arrestors, 23,000 volt oil circuit breakers mounted in brick cell

structures, the two motor generator sets and the main control and distributing switchboard.

The adoption of 550 volt power for all alternating current motor drives simplified the installation and effected marked savings in the initial cost and has proven entirely satisfactory in operation.

The surplus gas is used at the tin mills for all annealing, for the annealing furnaces and galvanizing pots at the sheet mill and for part of the annealing furnaces at the strip mills. A gas main also connects with the open hearth plant, gas being used for heating the mixer and for drying the ladles and steel runners. All open hearth furnaces are piped for gas and tar burning so that any surplus not required at the other plants and at week ends when they are not operating, can be used in the open hearth furnaces, eliminating all bleeding of gas. The total surplus gas is metered at the coke plant and also to each department using it. Regulating valves at each department maintain the pressure required at each plant. The gas as applied has replaced producer gas or coal firing and has substantially increased the efficiency and reduced costs at these departments.

The plant was built in remarkably short time. Construction work was started November 1, 1922, and despite the bad weather and delays during the winter

The following is a list of the principal motor applications at the plant:

MOTOR APPLICATION AT COKE PLANT

Application	No. Motors	Make	H.p.	Type	Frame No.	Rpm.	Control Type	Control Make
230 Volt D. C. Equipment								Semi. Mag.
Pusher Machine Pusher Ram.....	1	Westg.	60	MCA	70	475	Plugging	Cutler-Hammer
Pusher Machine Leveler Bar.....	1	"	30	"	50	525	Drum	"
Pusher Machine Bridge.....	1	"	30	MCB	50	525	"	"
Pusher Machine Door Ram.....	1	"	6	MCA	20	700	"	"
Larry Car Drive.....	1	"	30	MCB	50	525	"	"
Larry Car Swab Crane.....	1	"	2½	K	1	835	"	"
Door Machine Bridge.....	1	"	12	MCB	30	700	"	"
Door Machine Door Ram.....	1	"	6	MCA	20	700	"	"
Door Machine Door Hook.....	1	"	2½	K	1	835	"	"
Reversing Machine.....	1	"	7½	MCA	20	625-850	Magnetic	"
Coal Spillage Elevators.....	1	"	3½	SK	50	950	"	General Elec.
Coal Spillage Feeder.....	1	"	3½	SK	50	950	"	"
Quenching Locomotive Drive.....	2	"	50	HM	827		Drum	"
Quenching Locomotive Air Compressor.	1	GE	30	CP-26	B-3		Magnetic	"
550 Volt, 3 Phase, 60 Cycle Equipment								
Clay Mixer.....	1	GE	25	KT	346	875	Magnetic	Cutler-Hammer
Lime Mixer.....	1	"	5	KT	302	875	Manual	"
Limewater Pumps.....	2	"	7½	KT	750	1750	"	General Elec.
Quenching Pump.....	1	"	15	KT	753	1800	Magnetic	Cutler-Hammer
Ammonia and Hot Drain Pumps.....	3	"	7½	KT	750	1750	Manual	General Elec.
Tar Flushing Pumps.....	2	"	40	KT	327	1750	"	"
Coke Conveyor No. 1.....	1	"	5	KT	302	875	Magnetic	E. C. & M. Co.
Coke Conveyor No. 2.....	1	"	20	KT	342	860	"	"
Coke Conveyor No. 3.....	1	"	5	KT	302	875	"	"
Coke Conveyor No. 4.....	1	"	5	KT	302	875	"	"
Coke Wharf Sump Pump.....	1	"	1¾	KT	160	1150	Manual	General Elec.
Boom Conveyor Hoist.....	1	"	5	KTC	5150	1200	"	Sprague Elec.
Coal Duplex Feeder.....	1	"	10	KT	312	865	Magnetic	Cutler-Hammer
Coal Conveyor A.....	1	"	10	KT	322	690	"	"
Coal Conveyor B.....	1	"	20	KT	336	690	"	"
Coal Conveyor C.....	1	"	25	KT	332	855	"	"
Coal Conveyor D.....	1	"	15	KT	322	875	"	"
Coal Bradford Breaker.....	1	"	75	I	14	575	"	"
Air Compressors.....	2	"	50	KT	336	1155	Manual	General Elec.
Water Booster Pumps.....	2	"	75	KT	343	1150	"	Cutler-Hammer
Perfex Screen.....	1	"	5	KT	302	875	Magnetic	E. C. & M. Co.
Portable Conveyor (BP Bldg.).....	1	"	5	KT	160	1750	Manual	Sq. D Switch
Sample Room Laboratory.....	1	"	5	KT	732	1155	"	General Elec.
Car Haul.....	1	Ft. Wayne	75	M	10	720	Magnetic	Cutler-Hammer

Generated on 2024-09-07 22:02 GMT / https://hdl.handle.net/2027/mdp.39015080085387
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

months, the plant was ready for operation July 1, 1923, in accordance with the original date set for completion—just eight months after the beginning of construction.

The plant equipment was designed and constructed by the Koppers Company in collaboration with the engineers of the Weirton Steel Company.

The ovens were brought up to heat and first coke pushed July 7th as before stated, and the ovens have operated continuously on 11 hours and 26 minutes coking time, carbonizing 1060 tons of coal per day or 29 tons per oven per day without any leaks developing in the brickwork or overheating in any portion of the battery and establishing a new record for short coking time and production of blast furnace coke from a like number of ovens.

All coke from the plant has been used at the blast furnace and only the coke which passes over the 1¼-in. rotary grizzly screen is classed as furnace coke and sent to the furnace, the coke passing through the screen being separated, the nut coke being sold as domestic coke on the market and the breeze used at the soaking pits and burned under boilers.

The following average results of operations in December will give a good idea of what has been accomplished:

Gross coking time	11 hrs. 46 min.
Net coking time.....	11 hrs. 26 min.
Coal per oven per day.....	28.7 tons
Furnace coke per day over 1¼-in. revolving grizzly	661.0 "
Total coke yield—per ton of coal.....	75.75%
Furnace coke yield— "	63.07%
Domestic coke yield— "	6.98%
Breeze— "	5.70%
Total gas yield— "	11,360 cu. ft.
Tar yield— "	12.37 gals.
Sulphate yield— "	25.21 lbs.
Light oil yield— "	4.03 gals.

Average Analysis of Coal		Average Analysis of Coke	
Moisture	2.75%	Moisture	1.11%
Ash	9.25	Ash	11.79
Sulphur	1.01	Sulphur	0.72
Volatile matter	33.60	Volatile Matter.....	0.67
Fixed Carbon.....	57.17	Fixed Carbon.....	87.85

The following are the average results for the first 21 days of January, 1924:

Gross coking time.....	11 hrs. 46 min.
Net coking time.....	11 hrs. 26 min.
Total coke yield—per ton of coal.....	75.49%
Furnace coke yield— "	63.24%
Domestic— "	6.33%
Breeze— "	5.92%
Total gas yield— "	11,790 cu. ft.
Tar yield— "	13.13 gals.
Sulphate yield— "	25.50 lbs.
Light oil yield— "	4.10 gals.
Surplus gas	63%

The debenzolized gas has an average Btu. of 590.

The tar is of low specific gravity, rich in cresote and anthracene oil, high in tar acid approaching tar produced by low temperature coking processes and is in demand for creosoting and wood preserving purposes.

The sulphate is of good standard grade with large pure white crystals. The benzol plant was originally intended for the production of motor benzol, however, additional tanks have been added and changes made so that all of the product is now being made into nitration benzol, nitration toluol and zylol.

The plant has exceeded the guarantees and yields expected prior to its building. It was built to supply coke to the blast furnace to yield results equal to or better than obtained from beehive coke from coal from the mines of the company, and while the blast furnace and coke plant departments have had a relatively short time in which to co-ordinate their practices, the results so far have proven that a good coke can be made from the Klondike basin coal and that blast furnace results may be expected from this coke which will eliminate the necessity for using low volatile coal.

The following results from the blast furnace, which is lined for 600 tons, in August on straight ore and in December with scrap added to increase the hot metal production, will give an idea of the performances obtained with the use of this coke.

	August	December
Average day — tons.....	610.8	757.8
Average on ore only — tons.....	610.8	626.6
Lbs. coke per ton iron—lbs. on straight ore basis	2,078	1667-2001
Lbs. stone per ton iron.....	700	583
Lbs. ore per ton iron.....	3,880	3,015
Lbs. sinter per ton iron.....	486	369
Lbs. turnings.....	None	441
Per cent Mesaba ore used	76.0	91.5
Cubic ft. wind blown.....	43,290	43,875
Hot blast pressure.....	18.5	19.25
Hot blast temperature — deg.....	1,005	979
Top temperature — deg.....	355	~ 326

Average Iron Analysis:

Silicon	1.34	1.20
Sulphur	.034	.038
Phos.	.369	.284
Manganese	2.12	1.73

Coke used—By-product from 100% High Volatile Coal:

Per cent BP.....	81.9	100
Per cent Reverse.....	9.6	
Per cent Stock.....	8.5	

In October the open hearth plant made what is probably a world's record tonnage for a seven-furnace plant, producing 50,431 tons of ingots, using 38 per cent hot metal from the blast furnace and the balance light sheet scrap and crops from the blooming mill and finishing mills.

Elimination of Accidents

(Continued from Page 192)

12. In the manufacture of cartridges, conveyors play a big part in safely handling material in various processes in sequence, through packing, storage, and shipping entirely without a shock.

13. Pneumatic tube conveyors have a splendid application in the transportation of high explosives in small and isolated but frequent quantities, providing the minimum of risk by eliminating all local storage.

14. Pneumatic tube conveyors have advantages of safety in transmission of inter-departmental matter through factory departments

15. Pneumatic tube conveyors have been employed for the transmission of papers in railway yards.

16. Or, transgressing the subject of accidents, conveyors perform an additional office in safeguarding health.

17. Material handling mechanically and automatically has been in practice for a great many years, but regulated chiefly to bulk products and to some extent in uniform packages.

Heat Balance of Bureau of Mines Experimental Blast Furnace¹

Although Small Furnace Operation Shows High Radiation Losses, Comparisons Are of Great Value

By P. H. ROYSTER², T. L. JOSEPH³ and S. P. KINNEY⁴

THE writers have recently published data⁵ taken during the operation of an experimental blast-furnace carried out by the Bureau of Mines and the University of Minnesota. According to the furnace lines shown in the January issue of this journal⁶, the hearth diameter of the Minneapolis furnace is 20 in. and its active height 16 ft. 5 in. (tuyere plane to stock-line). Metallurgists have generally considered that a furnace as small as this will not operate. The difficulty in carrying out small-scale experiments of this nature has seemed to many furnace men to lie in the impossibility of attaining a sufficiently high hearth temperature. During the operation of the Bureau's experimental furnace the temperature of the furnace hearth was measured by means of a disappearing filament pyrometer. This information has been published⁷, and temperature measurements of a similar nature previously taken by the Bureau and by others were given for comparison. A study of these readings indicates that the hearth temperatures in a 500-ton furnace are not materially higher than those observed in the experimental furnace.

It is, nevertheless, possible to contend, as many do, that the results of the Bureau's experiments are inapplicable to large-scale practice, and logically to base this opinion on the number of heat units produced and consumed in the two types of furnaces. The heat lost through the furnace walls is a quantity generally conceded to be of minor importance in industrial practice. It is conceivable, and even probable, that this quantity may be excessively great in the case of a furnace producing only 2½ tons of iron per day. A small furnace must operate necessarily under the handicap of a large surface per unit of furnace volume. It will therefore sustain proportionately a greater loss of heat through its walls than the large scale furnace will. This loss of heat must be compensated for by high-blast heats, by higher coke consumption,

or by both. In the present state of metallurgical knowledge it is not possible accurately to predict how large this factor will prove to be.

No direct means of measuring the total heat lost through the furnace walls is at present available. An estimate of its magnitude, however, can be made by means of a thermal analysis of the furnace process. The purpose of this paper therefore is to ascertain the magnitude of this heat loss in the furnace experiments previously described in this series of articles. In order that the calculations may be more readily understood by the reader, similar thermal balance sheets for a number of large furnaces are given for comparison. The operating data used in computing these heat balances are given in Table I. These data were copied directly from the daily plant records, and are undoubtedly as typical of modern American blast furnace practice as any figures available at this time. It is obvious that the material balance of the various constituents charged into the furnace and discharged from it is not in every case consistent. No attempt has been made, however, to adjust the original figures to make them concordant.

Method For Computing the Heat Balance.

In developing the thermal balances in this paper, the methods of computation used are those adopted by Mathesius⁸. Other forms of calculation have been used⁹ but Mathesius' method is probably best known due partly to the fact that his calculations were reprinted verbatim in Johnson's textbook¹⁰. For the purpose in hand it is important that the heat balance be computed for each of the several furnaces by the same method, and preferably of one familiar to the reader, in order that a comparison may be most easily drawn.

The sum of the quantities of heat produced and consumed in each of the 14 furnaces is given in as concise a form as possible in Table II. A few changes of minor importance have been made. The sensible heat attributed to the moisture in the blast has been added to the heat of the blast, because this quantity is small in magnitude. The heats of reduction of MnO, P₂O₅, and SiO₂ are reported together; and similarly the heat used in the reduction of iron from Fe₃O₄ has been added to and reported together with the heat used in the reduction of iron from Fe₂O₃. A

¹Published by permission of the Director, U. S. Bureau of Mines.

²Asst. Metallurgist, North Central Experiment Station, Minneapolis, Minn.

³Assoc. Metallurgist, North Central Experiment Station, Minneapolis, Minn.

⁴Asst. Met. Chemist, North Central Experiment Station, Minneapolis, Minn.

⁵Progress in Blast-Furnace Research. Reports of Investigations, Serial No. 2524, Bureau of Mines, Sept., 1923, 6 pp.; *Skilling's Mining Review*, Oct. 20, 1923, p. 6; *Engineering* (London) Vol. 117, 3021, No. 23, 1923, pp. 667-8. *The Mining Review* (London) Dec. 15, 1923, pp. 966-7; quoted by J. A. Mohr, *Blast Furnace and Steel Plant*, Vol. 12, Jan. 1924, p. 10. Reduction of Iron Ore in the Blast Furnace, *Blast Furnace and Steel Plant*, vol. 12, January 1924, pp. 35-37, and February 1924, pp. 98-100; Significance of Hearth Temperatures in the Blast-Furnace Process. *Blast Furnace and Steel Plant*, March, 1924 pp. 154-158.

⁶Figure 2, p. 36.

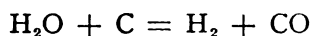
⁷Royster, Joseph, and Kinney; op. cit. *Blast Furnace & Steel Plant*, March, 1924, pp. 154-158.

⁸High Blast Heats in Mesabi Practice, by W. Mathesius, Trans. A. I. M. E., vol. 51, 1915, pp. 794-810.

⁹Richards' Metallurgical Calculation (McGraw-Hill) one vol. edition, 1915, pp. 294-301; Cornell, *Met. & Chem. Eng.*, vol. 12, 1914, pp. 747-50; Gillhausen, W. F., Investigation of the Material and Heat Balance of the Blast Furnace, *Mitteilung a.d. Eisenhütten-Mannisch, Inc. d.k. Hochschule (Aachen)*, 1913; Davis, F. W., Bureau of Mines, Report of Investigations, Serial 2502, July, 1923, pp. 7-10.

¹⁰Johnson's Principles, Operation and Products of the Blast Furnace, pp. 58-64.

more important change has been made by the writers in adopting Johnson's suggestion¹¹ that the heat used in the dissociation of moisture be computed from the observed H₂ content of the top gas rather than that this quantity be computed from the moisture contained in the blast. Johnson has pointed out that moisture in the solid charge may be carried down the furnace shaft so far that it comes into contact with incandescent coke and the reaction



takes place. In any case, if the gas analyses are correct, this hydrogen must be accounted for, while if the gas analyses are not correct, the heat balance is in error and probably valueless.

In reporting the gas analyses the writers have followed Perrott, Kinney, Sherman, and Blizzard¹² in denying the existence of methane as a possible constituent of blast furnace gas. Where CH₄ has been reported by the plant chemists it has been deleted from the analyses, and a suitable correction made in the H₂ and CO determinations; it being assumed that the supposed CH₄ reported was due to incomplete absorption of CO in the Orsat determination. In the case of the sensible heat of the metal and slag, the number

¹¹Work cited, p. 65.

¹²Transactions A. I. M. E., vol. 69, 1923, pp. 526-42 and pp. 543-84.

of heat units per pound has been taken to be directly proportional to the slag and to the metal temperatures as reported in items 8 and 9 in Tables I and III.

Details of Heat Production and Consumption In the Bureau's Furnace.

The average data for the Bureau of Mines experimental furnace while operating on the burden and under the conditions described in the preceding articles of this series are given in Table III. Complete analyses of the ore, stone, and coke charged into the furnace have appeared, together with a description of the physical characteristics of these three constituents¹³.

TABLE III—Operating details of Bureau of Mines' experimental furnace.

Furnace Dimension		Charge; Lb. per Ton	
Height	20 ft. 3 in.	Ore	3,889
Bosh diameter..	4 ft. 0 in.	Coke	3,218
Hearth diameter	1 ft. 8 in.	Stone	1,341
Bosh angle ..74 deg.	56 min.	Slag produced.....	1,566
Furnace Temperatures		Analysis of Charge; Per Cent	
Blast	750 deg. F.	Fe in ore.....	52.13
Top	660 deg. F.	SiO ₂ -Al ₂ O ₃ in ore....	12.35
Tuyere	1647 deg. C.	S in coke.....	0.83
Slag	1529 deg. C.	Ash in coke.....	12.17
Metal	1396 deg. C.	F. C. in coke.....	80.65

¹³Blast Furnace & Steel Plant, vol. 12, Jan. 1923, Tables I and II.

TABLE I - Operating Data from Fourteen American Blast Furnaces.

Item	Furnace	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Dimensions																
1	Height, ft.	80	80	88	90	80	92.5	90	95	90	85	--	85	88	--	86.9
2	Bosh dia., ft.	22	22	22	22	22	22	22	22	22	22	--	21	21.5	--	21.9
3	Hearth dia., ft.	16	16	18	17	15.5	16.6	17	17.7	17.3	17.3	--	16	17.3	17	16.8
4	Bosh angle	76.6°	76.6°	80°	78.6°	76°	77°	--	80°	80°	80°	--	78.6°	80°	80.5°	78.6°
Temperatures																
5	Blast °F.	980	950	1020	1025	890	1105	825	1000	1006	944	971	1150	1100	1183	1012
6	Top °F.	265	312	296	352	354	325	425	232	308	278	552	475	377	360	337
7	Tuyere °C.	1656	1710	1656	1640	1690	1821	1730	1595	1862	1849	1800	1648	1703	1638	1714
8	Slag °C.	1449	1493	1542	1451	1500	1528	1481	1437	1514	1545	1525	1473	1544	1544	1501
9	Metal °C.	1456	1464	1477	1437	1455	1459	1437	1437	1468	1471	1471	1444	1484	1475	1458
Charge; lb. per ton																
10	Ore	3890	3750	4408	4465	4090	3204	4435	4400	3490	3429	3306	4474	4218	4025	3970
11	Coke	1907	1892	1958	2070	2040	1704	2000	2085	1720	1950	1845	2460	2158	2213	2000
12	Stone	802	896	785	1310	956	723	898	1223	793	732	694	1267	839	753	906
13	Slag	905	985	885	1390	1086	800	1222	1470	910	910	785	1365	1020	900	1045
Analysis of charge; per cent																
14	Fe in ore	56.1	56.0	49.3	53.4	51.1	55.9	49.9	49.3	48.7	54.0	53.8	53.4	50.9	47.2	51.9
15	SiO ₂ -Al ₂ O ₃ in ore	8.2	8.2	---	10.3	11.9	7.4	10.3	11.5	9.3	7.4	7.3	10.2	10.6	9.5	9.3
16	S in coke	0.90	0.89	0.76	1.20	1.14	0.82	0.61	1.18	0.82	0.82	0.83	1.18	0.76	0.76	0.90
17	Ash in coke	12.0	12.0	10.3	13.2	13.2	11.0	10.7	13.0	11.0	11.2	11.2	13.0	10.3	10.3	11.6
18	F. C. in coke	86.23	86.20	84.93	85.26	85.44	88.14	88.90	85.37	88.26	88.20	88.24	85.31	84.89	84.91	86.45
Analysis of metal; per cent																
19	Si	1.37	1.14	0.97	1.29	1.27	1.59	1.12	0.96	1.27	1.70	1.76	1.51	1.43	1.18	1.32
20	S	0.031	0.030	0.044	0.049	0.036	0.032	0.033	0.049	0.034	0.041	0.029	0.035	0.038	0.041	0.037
21	Mn	0.71	0.73	1.18	0.65	---	0.80	1.84	1.62	1.34	0.71	0.76	0.68	1.03	1.68	1.06
22	P	0.084	0.084	0.224	0.095	0.200	0.085	0.324	0.206	0.131	0.084	0.084	0.100	0.250	0.225	0.155
Analysis of slag; per cent																
23	SiO ₂	32.6	33.7	34.8	35.0	32.7	36.0	35.8	34.0	34.2	37.1	36.6	34.9	36.0	33.7	34.8
24	Al ₂ O ₃	15.7	15.4	14.1	13.0	14.1	15.5	12.4	14.7	17.2	16.0	16.6	13.1	13.3	15.3	14.7
25	CaO	46.5	46.5	45.7	48.3	40.9	38.9	44.5	46.1	43.0	36.5	37.3	48.5	43.6	44.2	43.5
26	MgO	2.3	2.2	2.3	2.2	9.4	7.3	5.7	3.5	2.3	7.1	7.3	2.0	4.8	3.8	4.45
27	S	1.30	1.22	1.61	1.74	---	1.70	1.29	1.61	1.43	1.83	1.84	1.62	1.33	1.68	1.57
28	MnO	0.43	0.61	1.20	---	---	---	---	---	---	---	---	---	0.56	1.69	0.89
29	FeO	0.95	0.90	0.55	---	---	---	0.63	0.90	---	---	---	0.95	0.33	0.39	0.68
Analysis of gas; percent by volume																
30	CO ₂	13.2	12.7	11.7	12.9	13.0	13.2	12.8	14.5	14.9	12.6	11.9	12.5	12.2	12.4	12.9
31	CO	26.4	25.8	26.5	25.2	26.0	26.4	24.4	25.3	24.5	26.6	26.9	25.9	27.0	26.8	26.0
32	H ₂	2.3	2.6	3.2	2.6	3.1	3.8	2.3	1.1	3.7	3.8	3.6	1.4	3.0	3.5	2.9
33	N ₂	59.0	58.9	58.6	59.3	57.9	56.6	60.5	59.1	56.9	57.0	57.6	60.2	57.8	57.3	58.3
Analysis of gas; percent by weight																
34	CO ₂	19.6	19.0	17.7	19.3	19.5	19.9	19.1	21.2	22.3	19.1	18.1	18.5	18.4	18.8	19.3
35	CO	24.9	24.6	25.6	24.0	24.9	25.4	23.2	23.6	23.3	25.7	25.8	24.5	25.9	25.8	25.0
36	H ₂	0.16	0.18	0.22	0.18	0.22	0.21	0.16	0.16	0.26	0.26	0.25	0.09	0.21	0.24	0.20
37	N ₂	55.4	56.2	56.5	56.5	55.4	54.4	57.5	55.0	54.1	55.0	55.7	56.9	55.5	55.2	55.5
38	Production, tons per day	598	546	525	582	519	544	552	554	545	519	508	567	477	518	540

Analysis of Metal, Per Cent

Si	1.17
S	0.083
Mn	1.47
P	0.130
C	3.33

Analysis of Slag, Per Cent

SiO ₂	35.0
Al ₂ O ₃	7.8
CaO	50.3
MgO	3.0
S	1.85
MnO	1.68
FeO	0.83

Analysis of Gas; Per Cent by Volume

CO ₂	10.17
CO	24.93
H ₂	1.31
N ₂	63.59

Analysis of Gas; Per Cent by Weight

CO ₂	15.28
CO	23.84
H ₂	0.09
N ₂	60.79

Production, tons per day, 2.49

Heat Produced In the Experimental Furnace.

For each ton of metal made, the coke brings into the furnace

$$3218 \text{ lb.} \times 80.65\% = 2595 \text{ lb. C/ton metal}$$

The metal takes up as carbide 74.6 lb. C (2240 lb. $\times$ 3.33%) and the carbonates in the charge release 151 lb. of carbon (as CO₂). The carbon in the gas is therefore

$$2595 - 74.6 + 151 = 2671.4 \text{ lb./ton metal}$$

The gas composition, given in items 35 to 38 of Table III, shows that 1 lb. of top gases (dry) contains

$$0.04168 \text{ lb. C as CO}_2$$

$$0.10216 \text{ lb. C as CO}$$

$$0.14384 \text{ lb. total carbon}$$

The gases therefore weigh

$$\frac{2671.4}{0.14384} = 18572 \text{ lb./ton}$$

Hence, 1897 lb. of carbon is discharged as CO (18,572 $\times$ 0.10216) and 774 lb. as CO₂ (18,572 $\times$ 0.04168). The 151 lb. of C from the carbonates must be deducted from this, leaving 623 lb. of C as the amount actually oxidized to CO₂ inside the furnace. According to Mathesius' thermal constants, the CO generates

$$1897 \text{ lb.} \times 4446 \text{ B.t.u./lb.} = 8,434,060 \text{ B.t.u.}$$

and the CO₂ supplies

$$623 \text{ lb.} \times 14543 \text{ B.t.u./lb.} = 9,060,290 \text{ B.t.u.}$$

Since the N₂ entering with the blast is supposed to come out with the top gas unchanged, the weight of the dry air is

$$18572 \text{ lb. gas} \times \frac{60.97\% \text{ N}_2 \text{ in gas}}{77\% \text{ N}_2 \text{ in air}} = 14705 \text{ lb.}$$

The blast temperature being 750 deg. F., and its specific heat 0.248, the air brings in

$$14705 \times 0.248 \times 750 \text{ deg. F.} = 2,735,130 \text{ B.t.u.}$$

From the observed humidity (see Table I, January paper), 87 lb. of water per ton of metal accompanied the air as moisture. This adds a small amount of heat to the furnace, that is,

$$87 \text{ lb.} \times 0.49 \times 750 \text{ deg. F.} = 32,100 \text{ B.t.u.}$$

where 0.49 is the specific heat of steam.

Heat Accounted for in the Experimental Furnace.

The ore analyses 51.08 per cent Fe as Fe₂O₃ and 1.05 per cent Fe as Fe₃O₄. The Fe in the stone is present as ferric oxide and the Fe in the coke either as its sulphide or its carbide. The iron from Fe₂O₃ amounts to

$$3889 \text{ lb. ore} \times 51.08 \text{ per cent.} = 1986.5$$

$$1341 \text{ lb. stone} \times 0.80 \text{ per cent.} = 10.7$$

$$\text{Total iron from Fe}_2\text{O}_3 = 1997.2 \text{ lb.}$$

The reduction of this amount of oxide absorbs

$$1997.2 \text{ lb.} \times 3240 \text{ B.t.u./lb.} = 6,471,960$$

The 40.8 lb. of Fe reduced from Fe₃O₄ (3889 lb. ore $\times$ 1.05 per cent Fe) absorbs

$$40.8 \text{ lb.} \times 2970 \text{ B.t.u./lb.} = 118,420 \text{ B.t.u.}$$

One ton of metal contains 26.2 lb. of Si, 32.9 lb. of Mn, and 2.91 lb. of P. The reduction of these metal-loids consume heat, as follows:

$$26.2 \text{ lb.} \times 14,090 \text{ B.t.u./lb.} = 369,160 \text{ B.t.u.}$$

$$32.9 \text{ lb.} \times 2,970 \text{ B.t.u./lb.} = 97,710 \text{ B.t.u.}$$

$$2.91 \text{ lb.} \times 10,620 \text{ B.t.u./lb.} = 30,900 \text{ B.t.u.}$$

$$\underline{\underline{497,770 \text{ B.t.u.}}}$$

The decomposition of the carbonates absorbs 1830 B.t.u. per lb. of CO₂. To drive off 554 lb. CO₂ requires

$$554 \text{ lb.} \times 1830 \text{ B.t.u./lb.} = 1,013,820 \text{ B.t.u.}$$

The gas analysis indicates the presence of 16.7 lb. of H₂ in the top gas (18,572 lb. $\times$ 0.09 per cent). According to Johnson, this represents a decomposition of 149.2 lb. of water, and therefore a consumption of

$$149.2 \text{ lb.} \times 5760 \text{ B.t.u./lb.} = 859,400 \text{ B.t.u.}$$

The metal temperature of the average furnace (Table I) is 1458 deg. C. and for the Bureau's furnace only 1396 deg. C. Taking the 510 B.t.u./lb. used by Mathesius to represent metal at an average temperature, the heat charged to the iron is

$$2240 \text{ lb.} \times \frac{1396^\circ \text{C.}}{1458^\circ \text{C.}} \times 510 \text{ B.t.u./lb.} = 1,093,820 \text{ B.t.u.}$$

In this same way 1566 lb. of slag produced (Table III, item 13) at 1529 deg. C. (item 2) should be charged with

$$1566 \text{ lb.} \times \frac{1529^\circ \text{C.}}{1501^\circ \text{C.}} \times 900 \text{ B.t.u./lb.} = 1,435,690 \text{ B.t.u.,}$$

since Mathesius adopts 900 B.t.u./lb. for average slag and the average temperature (Table I, item 2) is 1501 deg. C.

The sensible heat of the top gas is calculated as follows:

Gas analysis $\times$ weight of gas $\times$ top temperature $\times$ specific heat = B.t.u.

CO ₂	15.28	18572	660	0.2169	406,240
CO	23.84	18572	660	0.2426	708,920
H ₂	0.09	18572	660	3.4090	37,610
N ₂	60.79	18572	660	0.2438	1,816,640
Total					2,969,410

The moisture in the ore entered as a liquid at 70 deg. F. and raised to 212 deg. F., (142 B.t.u./lb.), evaporated at 212 deg. (964.8 B.t.u./lb. latent heat) and superheated 448 to 660 deg. F. (0.48 $\times$ 448 = 215 B.t.u./lb. superheat). The total heat carried out by the moisture is therefore 1321.8 B.t.u./lb., and the analysis of the charge shows

$$\text{from ore } 3889 \text{ lb.} \times 11.89\% = 462.4 \text{ lb.}$$

$$\text{from coke } 3218 \text{ lb.} \times 4.85\% = 156.1$$

$$\text{from stone } 1341 \text{ lb.} \times 3.20\% = 42.9$$

$$\text{Total water in charge.} = 661.4 \text{ lb.}$$

The heat carried away by this moisture is

$$661.4 \text{ lb.} \times 1321.8 \text{ B.t.u./lb.} = 874,240$$

TABLE II - Distribution of Heat in Fourteen American Blast Furnaces: B.t.u. per Long Ton of Iron.

Furnace Number	Heat Generated							
	1	2	3	4	5	6	7	8
Combustion C to CO	4,890,600	4,903,530	5,075,840	5,079,050	5,275,800	4,435,380	5,321,980	5,243,300
Combustion C to CO ₂	7,547,320	7,385,080	6,989,800	8,245,920	8,140,950	6,831,880	8,446,950	8,929,610
Heat in blast (including moisture)	1,834,350	1,817,650	1,967,440	2,102,210	1,917,930	1,803,840	2,419,520	2,099,920
Total heat	14,272,300	14,106,300	14,033,100	15,427,200	15,334,700	13,071,100	16,188,500	16,282,800
Furnace Number	Heat Consumed							
	1	2	3	4	5	6	7	8
Reduction of iron oxides	7,070,620	6,804,000	7,040,990	7,725,160	6,771,570	4,041,080	7,167,870	7,028,210
Reduction of MnO, P ₂ O ₅ and SiO ₂	499,610	428,350	437,940	472,990	508,410	575,270	554,830	459,770
Calcination of carbonates	645,840	701,060	477,090	353,540	841,720	562,150	920,080	1,073,860
Dissociation of moisture	827,990	968,530	1,176,820	1,028,260	1,195,780	990,680	975,770	960,320
Carried off with the iron	1,140,830	1,139,270	1,167,290	1,125,950	1,140,050	1,143,180	1,125,950	1,125,950
Carried off with the slag	786,280	881,770	702,490	1,208,460	976,750	731,120	1,087,080	1,264,000
Carried off with gases (dry)	653,930	796,470	757,020	953,780	964,820	728,490	1,244,310	656,710
Carried off with moisture in top gas	479,540	496,670	770,780	637,480	606,300	552,900	695,120	623,290
Total heat accounted for	12,104,600	12,216,100	12,520,400	13,505,600	13,005,400	9,304,900	13,771,600	13,192,100
Heat unaccounted for	2,167,700	1,890,200	1,512,700	1,921,600	2,329,300	3,766,200	2,416,900	3,090,700

Furnace Number	Heat Generated						Average	Per cent
	9	10	11	12	13	14		
Combustion C to CO	4,194,410	5,478,340	4,970,460	6,460,410	5,960,190	5,650,520	5,209,980	54.12
Combustion C to CO ₂	7,869,030	8,037,130	6,904,350	9,440,093	8,294,860	8,497,180	7,969,300	52.19
Heat in blast (including moisture)	1,683,600	1,901,890	1,790,520	2,961,880	2,414,240	2,560,030	2,091,500	13.69
Total heat	13,747,000	15,417,400	13,665,300	18,862,400	16,669,300	16,713,700	15,270,800	100.00
Furnace Number	Heat Consumed						Average	Per cent
	9	10	11	12	13	14		
Reduction of iron oxides	5,491,020	5,999,580	5,762,750	7,740,740	6,956,160	6,155,350	6,553,900	42.92
Reduction of MnO, P ₂ O ₅ and SiO ₂	521,140	603,760	626,030	545,610	579,330	537,720	525,100	3.44
Calcination of carbonates	604,320	604,030	534,240	1,005,960	734,970	638,930	692,700	4.53
Dissociation of moisture	1,264,230	1,497,230	1,301,090	640,290	1,308,390	1,485,860	1,115,588	7.30
Carried off with the iron	1,150,240	1,152,590	1,152,590	1,131,430	1,162,770	1,155,720	1,145,100	7.50
Carried off with the slag	827,000	839,140	716,880	1,206,470	942,450	832,280	928,700	6.08
Carried off with gases (dry)	714,800	767,400	876,170	1,581,370	1,116,170	1,122,300	923,810	6.05
Carried off with moisture in top gas	734,460	538,750	576,430	775,790	600,120	810,220	634,200	4.15
Total heat accounted for	11,307,200	12,002,300	11,546,200	14,628,700	13,397,400	12,738,400	12,517,200	81.97
Heat unaccounted for	2,439,800	3,415,100	2,119,100	4,233,700	3,271,900	3,975,300	2,753,600	18.03

Heat Unaccounted for in the Blast Furnace.

The various amounts of heat calculated above are tabulated in convenient form in Table IV. It will be seen that the computed value of the total heat produced in the experimental furnace exceeds by a considerable amount the heat charged to the various items of heat consumption. The difference is termed "heat unaccounted for" and amounts to 4,927,180 B.t.u. per ton of metal (see last item of Table IV). If there are no errors in the data shown in Table III, and if the thermal constants used in constructing Table IV are accurate, this "heat unaccounted for" must be nothing more or less than the heat lost through the furnace walls.

TABLE IV — Distribution of Heat in Experimental Furnace; B.t.u. per Long Ton of Iron.

Heat Generated	
Combustion of C to CO.....	8,434,060
Combustion of C to CO ₂	9,060,290
Heat in blast (including moisture).....	2,767,230
Total	20,261,600
Heat Consumed	
Reduction of iron oxides.....	6,590,380
Reduction of MnO, P ₂ O ₅ , and SiO ₂	497,770
Calcination of carbonates.....	1,013,820
Dissociation of moisture.....	859,400
Carried off with the iron.....	1,093,820
Carried off with the slag.....	1,435,690
Carried off with the dry top gases.....	2,969,410
Carried off with moisture in top gas.....	874,240
Heat accounted for.....	15,334,500
Heat unaccounted for.....	4,927,100

In case of the 14 furnaces given in Tables I and II, the heat loss is large for the average furnace, and

varies widely from furnace to furnace. Its minimum is 1,512,700 B.t.u. per ton of metal (furnace No. 3) and its maximum 4,233,700 B.t.u. per ton (furnace No. 12). This represents a variation of nearly three to one. In terms of heat loss per unit of time furnace No. 3 shows 551,500 B.t.u. per min., and furnace No. 12 shows 1,667,000 B.t.u. per min., a variation here of more than three to one. Tables I and II are included in this paper merely for comparison with Tables III and IV. The thermal balances of the 14 industrial furnaces and of the experimental furnace have been calculated in the same manner. It is seen that the heat loss shown by the Bureau's small furnace is higher than the heat loss of furnace No. 12. The fact that the small furnace appears to lose 16.5 per cent more than does the worst furnace (from the standpoint of heat loss), substantiates the prediction that a small furnace will lose more heat than will a 500-ton furnace. If the heat loss for the 14 furnaces, as calculated, gave more concordant results, this comparison would have greater significance. As it stands, the nearest approach to a conclusion to be derived from the data presented and discussed in this paper is this: The small furnace loses 4,900,000 B.t.u. per ton, while a large furnace may lose any amount from 4,200,000 to 1,500,000 B.t.u. per ton. No metallurgist has yet developed an accepted rule for relating heat loss with coke consumption, therefore it is not possible at present to convert the heat loss handicap of the small furnace into its equivalent coke consumption handicap.

Cooling Water Heat Loss.

The amount of heat absorbed by the water flowing through the coolers used to preserve the bosh and

hearth of the blast furnace, while not usually determined, has been measured in a number of instances. In the Bureau's experiments this source of heat loss was determined, and for the experiment reported above amounted to 1,630 B.t.u. per minute. This includes the heat conducted through the 4½-inch brick lining of the bosh and of the tuyere breast, as well as the heat absorbed by the two tuyeres, their coolers, and by the cinder-notch coolers.

From Tables III and IV it is seen that the total heat unaccounted for per minute is

$$4,927,100 \text{ B.t.u./ton} \times \frac{2.47 \text{ tons/day}}{1440 \text{ min./day}} = 10,700 \text{ B.t.u./min.}$$

The cooling loss of 1630 B.t.u. per minute is only 16 per cent of the total heat unaccounted for, and leaves 9070 B.t.u. per min. still to be explained. The brickwork in the walls of the furnace hearth is 9 in. thick and in the hearth bottom 18 in. thick. The thermal conductivity of firebrick at high temperatures is not known with any certainty, but on any reasonable assumption the heat lost through this brickwork is a minor fraction of 9000 B.t.u. per min.

From the top of the bosh to the stock-line the mantle was lined with 18 in. of firebrick. The inside surface of this lining is 160 sq. ft. and the outside surface 218 sq. ft. The remaining heat unaccounted for (9000 B.t.u.), if assumed to be due to conduction through this brickwork, would indicate a mean transmission of 41 B.t.u. per min. per sq. ft. outside diameter, or 56 B.t.u. per min. per sq. ft. inside diameter. This high rate of heat transmission will need more verification before it can be accepted as proved.

Summary and Conclusion.

The writers have calculated by the usual method the distribution of heat in the experimental blast furnace, and have presented for comparison similar calculations for 14 large furnaces now in operation in this country. The heat lost through the walls of the small furnace was expected to be very heavy, but somewhat surprisingly it appears not to be as large relatively as was predicted.

The actual amount of heat unaccounted for, if called heat loss, gives a high value for the thermal conductivity of firebrick. The writers are not convinced that this value is a true one. No answer of any finality has been given this problem. The Bureau's plans for continuation of this work involve the construction of a new experimental furnace of about twice the capacity of the present one. The design for the new stack calls for a 27-inch firebrick lining in place of the present 18-inch lining. Further work on the new furnace, when completed, should throw some light on this "heat unaccounted for" and its identity.

Dr. Sauveur Lectures in Pittsburgh

At the March meeting of the Pittsburgh Section of the American Chemical Society, which was held on Thursday, March 20, in the auditorium of the Pittsburgh Station of the United States Bureau of Mines, 4800 Forbes Street, Dr. Albert Sauveur, Professor of Metallurgy and Metallography in Harvard University, spoke on "The Behavior of Steel Under the Action of Heat," a subject of great interest to ferrous metal-

lurgists and to iron and steel chemists. The address was illustrated by lantern slides.

Dr. Sauveur is regarded generally as the Nestor of metallography. He was formerly editor of "The Metallographist" and of "The Iron and Steel Magazine," and he is the author of a standard treatise on "The Metallography of Iron and Steel." In 1913 he



DR. ALBERT SAUVEUR

was awarded the Cresson Medal of the Franklin Institute and he recently received from the Iron and Steel Institute of Great Britain the Bessemer Medal for 1924, "in recognition of his eminent services in the advancement of the science of metallurgy of iron and steel."

To Electrify Worcester District Plants

The American Steel & Wire Company is undertaking an almost complete electrification of its three plants in Worcester, Mass., where special products of the corporation are manufactured. Eleven steam engines in the North, South and Central Works will be scrapped and supplanted by Westinghouse Type CS electric motors with a total of 12,000 horsepower, ranging from 1 to 250 hp. for each motor.

Through a special 10-year agreement with the New England Power Company, each plant will be supplied with three independent power sources, a triple protection against interruption of the operation of the mills. Power will be received at 13,000 volts and stepped down by transformers to 550 volts for the motors. Oil circuit breakers and switching equipment for the distribution of this power have been ordered from the Westinghouse Electric & Manufacturing Company.

When completed, this will constitute probably the largest electrically driven wire mill in the country.

CURRENT TECHNICAL DIGEST

Three Score Years and Today

Everywhere, on every hand, we see the rapid march of progress, and recently while visiting the Cambria Plant of the Bethlehem Steel Company at Johnstown, Pa., the developments in steel making and processing were forcibly brought to mind by one of the pioneer steel converters, which is located in the offices of this company.

In an interview with Mr. D. M. Stackhouse, of the Bethlehem Steel Company, we learned that this converter is a most interesting historical metallurgical relic, one of Wm. Kelly's early steel converters, in which he made steel at the Cambria Iron Company's plant in 1857.

A pictorial contrast is presented to show the advertisement in the art of steel making. One picture represents one of the earliest converters, the other picture illustrates the most modern converters in use today.

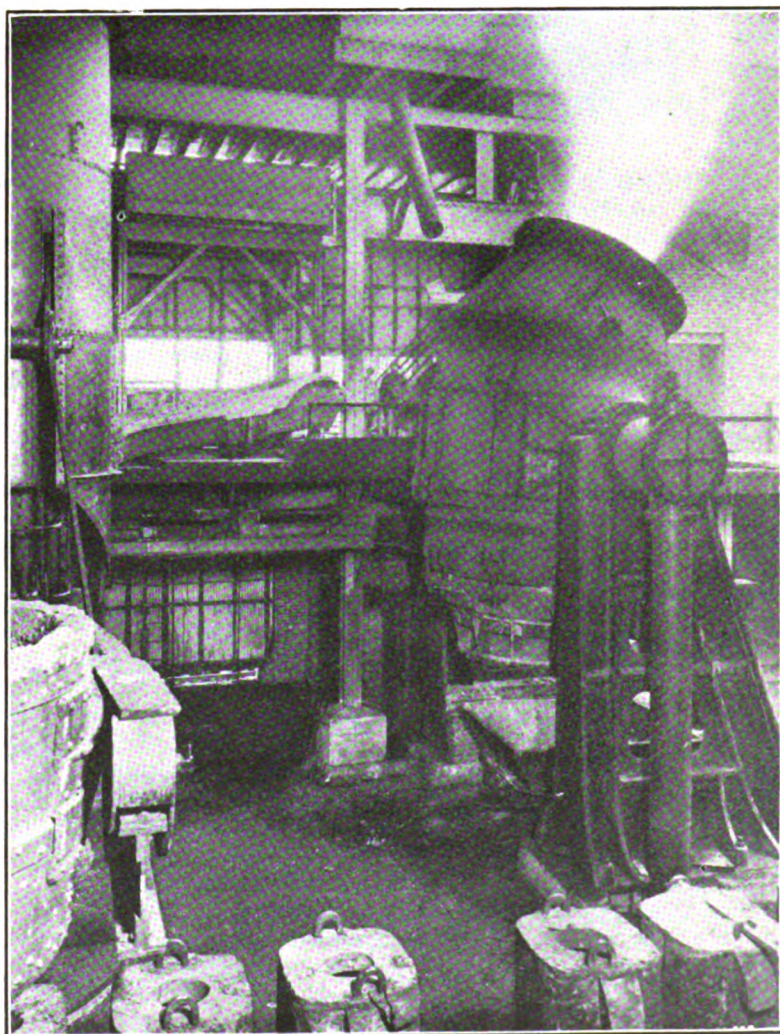
In 1851 William Kelly, who then operated a small iron works at Eddyville, Ky., conceived the idea that if air was blown through liquid pig iron, the impurities would burn out, leaving pure iron. This idea was brought about through Kelly's observations at a puddling furnace. In watching the charge in the furnace he noted that the cold air, which was drawn into the furnace through natural draft, heated the sides of the puddle ball, which on the contrary seemed to him, should cool the charge. He became interested in this phenomena and through his experiments developed the method of forcing air through hot metal to purify it. Kelly named his method the Pneumatic Process. About the same time Henry Bessemer was conducting similar experiments and arrived at the same conclusion which resulted in the Bessemer Process.

Further researches by both Kelly and Bessemer proved that their theories were correct, that manganese, silicon, and carbon would oxidize under both processes, and that the iron itself would not burn unless subjected to a continual blow. The theories advanced by both men also proved that in the oxidation of these elements sufficient heat was developed to keep the metal fluid, and purify it without the addition of any other fuel. This is one of the advantages of this process over the open hearth practice.

Mm. Kelly and Henry Bessemer made puite a number of these converters, the earlier ones being stationary, the blast being blown through the sides. Some of Kelly's earlier experiments were witnessed by the late James H Geer, a native of Johnstown. In relating his experiments he said that the pig metal

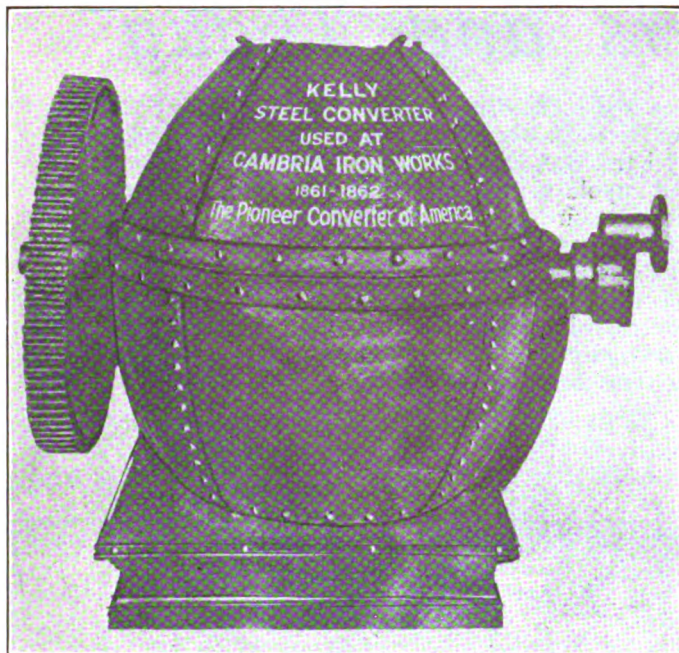
was first reduced in a foundry cupola. About 300 lbs. of hot metal constituted a charge, and a foundry ladle carried by hand was used for transporting the hot metal from the cupola to the converter. In one of the first trials, the pressure used in blowing the air through the converter, was so strong, that it blew the liquid pig iron out of the converter. On the next trial however, the blast pressure was reduced and the process resulted successfully, a heat of steel being produced. The steel was again poured into a foundry ladle, and then into rectangular molds 3 in. wide by 4 ft. long.

Tests of the steel were made in the company blacksmith shop, and while no record exists of the actual results of these tests, there is no doubt that the steel



cracked when worked hot. No method existed at that time for the elimination of red shortness in steel, Henry Bessemer's early trials were also failures, due to the same causes. Later when Henry Mushet discovered that if manganese was added to the bath after the heat was blown, the red shortness disappeared, and then this process of Kelly's and Bessemer's became a commercial success.

It seems that Kelly's efforts were confined to invention only, as he demonstrated his lack of business foresight by neglecting to take advantage of the patent laws of the United States, and it was not until after



Henry Bessemer made an application for the patent rights of America did Kelly make any effort to commercialize his activities. He was granted a patent over Henry Bessemer on the grounds of priority of invention.

The result of this invention was immediately apparent, inasmuch as more uses for steel were immediately found, and the consumption of steel per capita in this country increased far beyond the comprehension and dreams of the men in the industry at that day.

William Kelly was born in 1811 and died in 1888. He accumulated a small fortune from the royalties which accrued from the use of the Kelly Pneumatic Process.

A. I. & S. E. E. Iron and Steel Cost and Practice Chart

By B. R. SHOVER*

The idea of publishing a chart showing costs and practice was suggested by Mr. John F. Kelly, business manager of the Association, at whose request the writer consented to undertake its compilation.

Although there are few, if any, such plants in existence, a balanced installation was assumed in order to define the scope of the work, and also to indicate relative values.

*Consulting Engineer, Pittsburgh, Pa.

In estimating "Cost of Installation," the attempt was made to assume average construction and not take either the most expensive or the cheapest.

Practice, as represented by figures for "Raw Materials" and "Products," are the closest even figures to the true or weighted averages of tonnages running into the millions, and the figures on the charts are believed to be representative of average conditions as regards different plants, variations in the character of raw materials, etc.

Obviously the greatest problem was "Costs", for while a large amount of data collected over a period of years was available, hardly any two concerns use the same captions on their cost sheets, and even if such is the case, comparison showed a great difference in the interpretation of those captions as to what items of cost should be included. In many cases certain figures were so far off from the average that they had to be neglected.

The basis of the cost figures in each column is the curves shown at the top. These were made by changing the available costs to correspond with a plant of the size assumed, and the figures finally accepted represent the combined judgment and experience of several engineers and steel experts. The costs were then spotted on cross section paper at points corresponding to the labor rates prevailing for their different years, and while the resulting "target" greatly resembled the effect of a charge of bird shot, there was still a definite direction, and by averaging the costs in different labor rate zones, points were secured from which the shape and direction of the curves could be produced.

It will be noted that in every instance except Coke Ovens, "All Other Costs" go up with the increase of common labor rates more rapidly than "Department Labor," which can only be explained by extra profits being taken by concerns furnishing materials used in repairs, etc. This was very noticeable when an attempt was made to check the curves from figures obtained, after the labor rate was reduced, when the drop in "Department Labor" was very much more rapid than in "All Other Costs," and it is to be regretted that sufficient data was not available to show this effect.

As previously stated, there was considerable difference in the itemized costs of the various plants, but this difference was marked less for "Total Cost Above," and while different plant layouts and equipment would account for some of the discrepancies, methods of cost accounting are probably responsible for more. The divisions given on the chart were obtained by reducing all itemized costs to a 40c base in proportion to the curves, and then averaging these results.

This chart is believed to be the first of its kind and should it prove useful, it should be revised from time to time in order to be of value, and with this end in view the Association would welcome criticisms of this issue and suggestions for possible future editions.—Iron and Steel Engineer.

Aerial Mapping of New York

New York has been mapped from the air. The last flight of the greatest aerial photographic mapping project has been completed. Over 2000 negatives were

secured. They are now being corrected and assembled. About 3000 miles were flown and the five boroughs—Manhattan, the Bronx, Brooklyn, Queens, and Richmond—have been mapped. Three planes were over the city whenever there was a good photographic day. Included in the squadron was a Fokker C, 2-camera plane purchased especially for this contract as it is particularly adapted for high-altitude photography.

The camera used was the Fairchild automatic aerial camera with the "between-the-lens" shutter. It weighs 42 pounds, has over a thousand parts and is one of the finest examples of automatic precision machinery ever made. This is the official camera of the U. S. Army and Navy, the Canadian Government, and the Brazilian Government.

The map pictures the city with the minutest detail—every structure from the contractor's temporary tool shed where construction is going on, to the skyscraper, backyards, gardens and parks with every tree and bush visible, avenues and alleys, streets and unrecorded foot paths, big league ball parks, water front clubs, with their yacht and motor boats, the boardwalk of Coney Island, and crowds of people appearing like small black dots. Even the congestion of traffic on busy thoroughfares is clearly shown.

Two distinct photographic maps are being made. The first includes the area of approximately 400 square miles within the official city limits at the scale of one inch equals 600 feet, in 140 sections, each about 14 x 21 inches. These sections are to be assembled in groups of four, to correspond with the 35 sectional plan maps laid out by the Board of Estimate and Apportionment.

The second map is being made at the scale of one inch equals 2000 feet, and covers 625 square miles, including the city proper and portions of the counties of Westchester and Nassau in New York State, and that part of New Jersey contiguous to the city. The completed map at this small scale will measure 10 by 8 feet.

Few days are suitable for photographic mapping as there must be little haze and no clouds. Prints with clouds and cloud shadows are rejected. The shore line had to be photographed at low tide. This requirement proved difficult as low tide could not be later than 2 p. m. on a day when other conditions were favorable. In one instance there was a wait of several weeks for a suitable day to get part of the shore line. It was also imperative that flying be completed before snow set in. Some of the work for the map mosaic was done at 16,000 feet altitude in the Fokker, too high for the plane to be seen with the naked eye. For this work a short focal length camera was used to take photographs at a very small scale for checking controls. Many times the photographic squadron started out on days that seemed suitable, only to be compelled to return without pictures on account of haze or cloud formation.

If the 2000 exposures necessary to cover the entire area with an allowance of 50 per cent end and 50 per cent side overlap were matched together they would make a single strip map covering 800 linear miles on the ground. The greatest accuracy was required. Negatives showing very small degree of tilt have to be adjusted in the printing process. All prints have to be brought to the required scale; a different ratio of enlargement or reduction is required for practically

every print. This requires a finely calibrated adjustment of the enlarging camera.

In his recommendation to the Mayor, Arthur S. Tuttle, Chief Engineer of the Board of Estimate and Apportionment, wrote: "The numerous advantages which an aerial map of the entire city would afford in the study of municipal problems are too apparent for discussion."

Success is due primarily to the "between-the-lens" shutter. In 1918, Mr. Fairchild tested every known make of camera shutter and found that the largest exposure was 1/125 of a second using an opening of $\frac{5}{8}$ inch. He developed his first "between-the-lens" shutter in the spring of 1918. It ran at a speed of 1/220 of a second and had an opening of $2\frac{3}{8}$ inches. The efficiency of this camera was 70 per cent. There were then no others on the market that had so high efficiency; most of them averaged around 50 per cent.

His newest camera, known as the five-mile aerial camera, has a high efficiency shutter with a 4-inch opening, and a speed of 1/125 of a second. This is the same as the speed of the old cameras in 1918, but this new shutter covers an area about 45 times larger than the old type. A lens of "F-5" 20-inch proportions is used, working at all times at full aperture. The shutter is of exceptionally rugged construction. On a recent break-down test it stood up for over 20,500 shots, losing only a negligible percentage of its speed and accuracy.

Another remarkable feature of this camera is that on special high-altitude photographic work it is operated from an enclosed cabin through the floor of the plane, being suspended on a special carriage. Before the plane leaves the ground, adjustments are made so that when in flight (approximately 80 miles an hour) and at a set altitude over the country to be mapped, the camera automatically makes the necessary exposures. There are about 110 exposures to 75 feet of film.—Science Notes.

Statement on World Conditions

Nowhere in the world is the outlook more favorable than in the United States, according to General Guy E. Tripp, chairman of the board of the Westinghouse Electric & Manufacturing Company, who has just returned from a trip around the world, visiting Japan, the Philippines, China, India and Europe. "In Europe, France is at present leading the nations, while in the Far East, Japan alone shows commercial initiative," General Tripp declared.

In Europe, according to General Tripp, conditions are most promising in France. "France is very busy, as is obvious to any visitor," said the general. "Her exports are now exceeding her imports; thus the low price of the franc is actually helping her to improve her general situation.

"England is not yet out of her difficulties, her unemployment problem being especially serious. Her Labor government, though complacently accepted by most Englishmen, is apparently inherently unstable. If Premier MacDonald is not sufficiently radical, he will likely be deposed by his own party, while if he does become radical, there are enough conservatives left in England to force him out.

The immense potential strength of the British Empire is, however, a factor of the highest importance. Great Britain controls practically every stra-

tegic point in the great trade belt passing through the Mediterranean and encircling Asia. Among these points are Gibraltar, Malta, Suez Canal, India, Strait Settlements, Singapore, and Hong Kong. As long as she retains these outposts, her position as the leading world power can hardly be jeopardized by difficulties at home. Incidentally, the United States, possessing Manila, the Philippines, Hawaii and the Panama Canal, ranks second as a world power.

"But behind every phase of the individual and commercial situation in Europe lies Germany. She possesses unequalled industrial resources, both as to physical plant and trained men, and she will quickly place herself in position to challenge the leadership of any other nation just as soon as she can free herself from her present difficulties.

"In the Far East, Japan is an outstanding figure. She alone of all the oriental nations needs no extensive help from Europe and America. Though the destruction caused by the earthquake was enormous, the destroyed cities will be rebuilt on a very much better scale and the buildings will be as proof against earthquakes as it is possible to make them. The Japanese are doing the reconstruction work themselves, and the technical and financial experience thus gained will undoubtedly be worth the price to this progressive and energetic nation.

"In the Philippines, China, India, and the other Asiatic countries, there are prospects for extensive industrial development, but generally speaking, it will be done by Europeans, Americans and Japanese. There is, apparently, no racial desire for improvements and progress as we understand these words.

"China is a conspicuous example of the oriental tendency to resist occidental ideas. If the accounts of Marco Polo, who traveled through China in about A.D. 1300, are to be believed, China is no further advanced toward our standard today than she was 1,000 years ago. Whole districts are still being periodically ravaged by famine simply because no one cares enough to improve the roads so that food supplies can be brought from other provinces.

"It is not for us to pass judgment on this attitude of the oriental peoples. They believe that their philosophy is better than ours and that they gain more out of life than we do. Perhaps they are right and perhaps time will show that theirs is the more enduring civilization. In the meantime, however, the American business man must not be deceived in believing that Asia industrially is comparable with Europe and America.

"At present China is in the throes of a very serious civil war. Dr. Sun Yat Sen may quite possibly gain control of Southern China. If he could impose a stable and progressive government, he might do his country a great service. Unfortunately, however, he has advanced political ideas that seem to be quite unsuitable to the Chinese character, so that his efforts may result in no lasting good. Incidentally, there was a strong anti-American sentiment in the Canton district last December, due to the fact that American destroyers participated in preventing the Sun forces from seizing the customs, which are pledged to pay the interest on Chinese debts. The feeling was that America was playing with China's enemies, but this feeling will probably prove ephemeral only, since America is a sincere friend of China.

"In both India and the Philippines there is a strong

native sentiment for independence. To grant this in either case, however, would probably be very injurious to the people themselves. The natives are not yet fit for self-government, and they would quickly revert to their original state were the influence of Great Britain or the United States withdrawn.

"An interesting incident illustrates the popular feeling in the Philippines. While traveling through the country outside of Manila, our party came to a water-hole where several families, including men, women, children and buffaloes, were deporting themselves. It made an interesting picture and the bathers were requested to pose. One fine looking young man refused to do so. When asked his reason, he replied in perfectly good English:

"'You will show that picture in the United States and say these are the kind of Filipinos who want independence.'

"'Aren't you grateful for these fine roads and other things that the United States have given you?' he was asked.

"'We thank you for what you have done, but we want our freedom,' was his reply."

—Westinghouse Electric Bulletin.

To Spend Billions for New Equipment in 1924

During 1923 more than three billion dollars were spent by American railroads for fuel, material supplies, and maintenance of equipment, and the expenditures for 1924 are expected again to reach this staggering total.

"The general prosperity of the country is reflected in these figures," says the Washington Star. "They mean, first of all, that there has been a great volume of business in the country, for the freight records constitute one of the surest indexes of business volume." Most other papers also feel that the fact that the roads are busy hauling freight is a sure sign the factories are busy making it.

The proposed expenditure of three billions more in 1924 has caught the attention of financial writers and experts in general. Arthur D. Welton, in the Philadelphia Public Ledger, writes:

"Today every one is looking forward with hope and confidence. There might have been a conspiracy to force a change, it came so suddenly. Judge Gary caught the ball and carried it back to midfield with the announcement of his satisfaction with conditions and an extra dividend for United States Steel. The Stock Exchange caught a forward pass and gained twenty yards in the face of weakening bear opposition, and since then any one can get through for a touch down.

"The railroads have so far recovered their confidence that they are planning to spend more billions, just as if Congress was not going to do all kinds of fearsome things. If the message that comes through the air is correctly interpreted, Congress isn't going to do anything fearsome at all. It isn't the season for fearsome things. Radicalism thrives only on disaster, and disaster is not popular. Business is going on whether any number of Congressmen like it or not.

"Considered in relation to each other and with all allowances made for extraneous influences, the present condition of business warrants the confidence of the railway executives in adopting such a program of large expenditure."—Laclede-Christy Bulletin.

Following is the resume of leading articles and market reviews appearing in Iron Trade Review during March.

March 6—

Production of pig iron in February totaled 3,064,536 tons compared with 3,015,480 tons in January. The daily average in February was 105,673 tons in contrast with 97,273 tons daily in January. This was the first time since last October the daily average advanced to over 100,000 tons. The number of furnaces operated at the end of February was 262, or 14 more than the last day of January and 31 more than the last day of December.

Iron Trade Review's composite of 14 leading iron and steel products this week is \$43.24 against \$43.39 in the week preceding. The lower composite is due chiefly to the easier price conditions in the pig iron market. Although shipments of pig iron continue on a large scale, buying is held in abeyance and prices this week in some of the leading producing districts are 50c lower than last week. Steel prices are holding fairly uniform, with an exception with respect to plates. The conspicuous feature of the trade is the high operating record of the steel companies; U. S. Steel Corporation units this week registering 94 per cent of the steel ingot capacity, and 88 per cent of the blast furnace capacity.

Iron Trade Review's European representative at London cables that German competition is becoming more active, the German steel producers meeting the export prices quoted by Belgium and France.

A description is given of the technical work involved in the construction of airplanes for the American government, with particular reference to some manufacturing problems that are general in scope.

The Washington correspondent of Iron Trade Review contributes an article analyzing the effect of the recent agreement in the bituminous industry.

March 13—

The U. S. Steel Corporation operations this week are at 96 per cent of capacity, practically maximum, and the independents average 85 per cent. The steel corporation plants in February shipped on the average 6,000 tons daily over the daily record for January. The gain in unfilled orders was 114,000 tons, indicating that the corporation booked about 260,000 tons more in February than in the preceding month.

The third highest rate of ingot output in history is registered for February. The daily average was 151,227 tons, equivalent to an annual rate of 47,030,000 tons. The February record was succeeded only in April and May, 1923.

Iron Trade Review's market composite this week is \$43.27, compared with \$43.29 the week preceding.

Producers of sheet bars are booking orders for second quarter at \$42.50 and prices on semifinished material generally are unchanged. Weakness is noted in the market for some finished lines, and also in the pig iron market.

The fabricating of hydroelectric units is described by H. R. Simonds, Boston representative of Iron Trade Review. The article gives details of some new problems developed in the construction of a 70,000 hp. turbo-generator.

The construction of barges with steel channels, producing a hull of extraordinary strength, also is described in this issue.

March 20—

The railroad and building industries develop new and extensive demands, but in other departments of finished steel, buying is backward. Car orders last week totaled 8,000 and the number of car orders since January 1 is estimated at 75,000. Car building plants in the Chicago district are filled to October 1. The pig iron market is featureless and some resale iron is appearing at Pittsburgh at \$22 Valley basis. A Tennessee furnace is shipping iron by rail and water and competing with Chicago furnaces at northern points.

Iron Trade Review's composite this week is \$43.25 compared with \$43.27 the preceding week.

Iron Trade Review's European representatives report that operations in the Ruhr now are at 60 per cent. Recent competition by Germans has given the Ruhr plants sufficient orders for three month's operations.

John D. Knox, Associate Technical Editor, at Pittsburgh, contributes an article describing the process of lithographing steel sheets, giving the method employed at a typical plant working up 72,000 sheets daily.

March 27—

Less activity is noted in the iron and steel markets this week, with the exception of buying for railroad and constructional needs. The railroads are taking about 40 per cent of the output of the mills. The Steel Corporation is maintaining operations at nearly 97 per cent though some of the independent plants have reduced their rates slightly, and at Youngstown, Pittsburgh and elsewhere, open-hearth furnaces have been put out. The majority of consumers of iron and steel are buying close; this is noted particularly in the sheet market. The political situation at Washington is given by many buyers as their reason for reluctance in closing. The Ford Motor Company is figuring on 15,000 tons of automobile sheets. Sheet prices are showing weakness and in some districts steel bars are offered at 2.30c, Pittsburgh.

The market for Lake Superior iron ore is about to be opened probably with a reduction in price from last year's level. Some of the producers have quoted less than last year's prices on the largest single tonnage offered in the open market, 250,000 tons for the Ford Motor Company.

Iron Trade Review's European manager at London, cables that the enthusiastic expectations of an agreement on the reparation question on the basis of Dawes negotiations may not be realized, as the Committee of Experts is having difficulty in agreeing, and political wrangling is being intensified, with possible consequences of nullifying much of the committee's work. The steel mills in the Ruhr and France and Belgium are booked for several months, while British mills lack orders.

The method adopted by a large steel casting company in the Chicago district for apportioning costs according to each job is described in this issue. The price to buyer is based on cost rather than weight. Running inventories are maintained to show stock and other necessary feature.

Iron Trade Review has been presenting each week brief, descriptive articles entitled "Large Uses of Steel in Small Ways." Spinning rings and travelers, license plates, toys, steel, wool, cotton ties, pens, hypodermic needles, pins and corsets, are some of the subjects already covered.

The POWER PLANT

Power Plant Management*

By ROBERT JUNE†

THE fact that coal prices have shown no tendency to recede in recent years has caused power plant operators in many sections of the country, not generally regarded as natural oil burning localities, to consider and frequently to adopt oil as a boiler fuel. In this paper we will deal first with the advantages and disadvantages of fuel oil, and then take up certain factors in the efficient use of fuel oil which have not heretofore been discussed at any great length in the many articles which have appeared in the press on this subject.

Comparative Cost of Oil and Coal.

The first cost of oil and coal does not tell the story of the comparative advantages of these two fuels. Many other factors such as availability of supply, increased boiler efficiency, comparative labor costs, storage factors, etc., have to be taken into consideration. Nevertheless our starting point is the actual di-

This is the fifth in a new series of articles by Robert June the well known authority on Power Plant Management. The articles are written from the point of view of the managing executive and deal with the dollars and cents end of Power Plant Operation and Maintenance. Succeeding articles deal with such live topics as Safe and Efficient Boiler Operation, Stoker Operation and Maintenance, What Management Should Know About Coal and Ash Handling Equipment, Steam Piping, Efficient Turbine Operation, etc. The series is timely and should prove of value to our readers.

rect comparison in cost of B.t.u. per pound for each fuel. Fig. 1 shows the comparative first cost of fuel oil. Table I developed on a different basis takes into consideration the variation in efficiency with the two fuels, but is based on a constant calorific value for coal and oil.

Advantages of Oil Fuel.

1. Handling costs are reduced; the boiler-room staff is cut fewer firemen, coal passers, helpers, etc., are required, the reduction being approximately in the ratio of five to one.

2. Ease of fire control, ignition, regulation. In an exigency, such as, for instance, a failure in water supply, the oil fire can be promptly extinguished. Much time is saved in bringing up the pressure; 150 lbs. can be secured from cold water in a half hour.

*Copyright 1923, by Robert June.

†Associate Member A. S. M. E.

3. Since combustion is nearly perfect, much higher capacities and efficiencies obtain. Excess air is held to a minimum. The opening of furnace doors for cleaning or working of fires is dispensed with; furnace temperatures are, accordingly, almost constant.

4. Oil in storage does not lose its calorific value, as does coal. Moreover, there is little danger from spontaneous combustion.

5. The refuse from the combustion of fuel oil is insignificant, and of easy disposal. The boiler-room is free of ashes and dust. The equipment is spared the

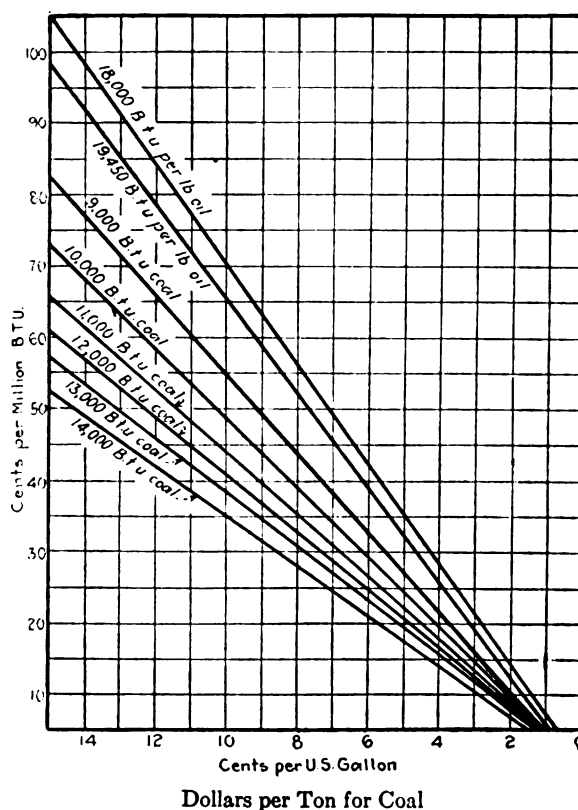


FIG. 1. COMPARATIVE WORTH OF COAL AND OIL
Courtesy of Power"

deleterious effects of such abrasives. Annoyance and damage to surrounding property is minimized.

6. Smoke can be practically eliminated.

Disadvantages of Oil Fuel.

1. Fire Hazard: Apparatus using oil for fuel, however safeguarded, introduces a distinct hazard which should be recognized.

2. Storage: Oil storage not only offers more hazards than coal storage, but it frequently calls for the use of a great deal more space. The table of

storage capacities permissible under laws of National Board of Fire Underwriters, shows that unlimited capacity may be stored at a minimum of 30 feet from the nearest building line. The laws deal at length with the thickness and size of vent and fill pipes, cover boxes, indicators, filters, etc., making a complicated and expensive storage installation.

3. **Reliability of Supply:** Fuel oil must be transported in special cars and special delivery wagons of which there are a limited number available at any one time. Coal shipments so far exceed the shipments of oil that the transportation of coal is a chief source of revenue to the railroads. If coal cars should be delayed in transit, the roads would soon become blocked and demoralize the whole system of freight movement. Production of bituminous coal has always been adequate, the coal must be moved, consequently the supply has always proved reliable. Coal hauling by local teamsters is more flexible than depending upon one company for delivery of fuel in a tank wagon.

4. **Price Stability:** The history of the oil market shows wide variation in price, ranging from 2c per

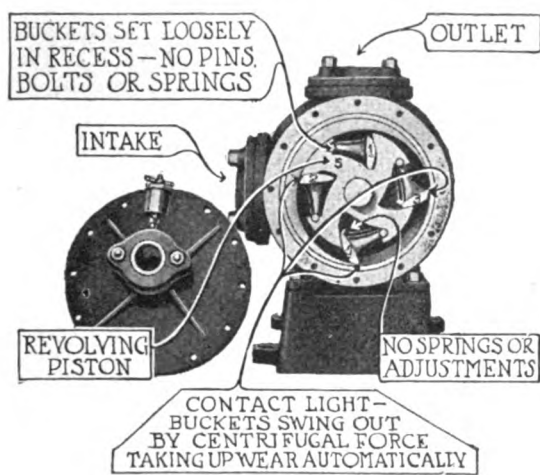


FIG. 2—Cross section rotary pump.

gallon up to as high as 7.5c. Present quotations are still subject to fluctuation and it is doubtful whether a contract could be made to guarantee a fixed reasonable price and delivery over a satisfactory period of time. The coal market, insofar as steam sizes go, has been very much more stable than the oil market. Moreover, coal prices today are regarded as near the top and any tendency to boost them seriously would meet with tremendous resistance all over the country. There is no such public sentiment against increases in oil prices as there is against increases in coal prices.

5. **First cost of Equipment:** A modern fuel oil plant consisting of duplicate storage tanks, oil heaters, pumps, etc., and reliable workmanship for its installation is estimated to cost approximately \$30 per h.p. Up to date, mechanical stoker equipment consisting of complete stokers, which will ordinarily outlast the life of an oil plant, auxiliary apparatus including modern ash removal system and labor for installing should not exceed \$18.00 per h.p., a saving of nearly 40 per cent over a fuel oil plant.

6. **Boiler and furnace maintenance costs** will be higher with oil, unless they are especially constructed for burning it. In localities where feed water tends to form considerable quantities of scale, the repair

costs are likely to be much increased by reason of the intense temperature developed in the furnace.

Handling in Bulk.

The decision as to whether to use fuel oil will depend entirely upon local conditions. The above points are suggestive of the factors which must be taken into consideration in considering use of oil in any given plant. The final decision will be made upon local conditions. Let us assume that oil is to be used. We have then the problem of handling it in bulk quantities. This presents a problem which has not been generally discussed.

Let us assume that we must take care of an average of one or more tank cars within each 24 hour period. Where gravity discharge is possible, it is desirable to place 10-inch pipes in a vertical position in the center of the rails and discharge the oil through these pipes into the storage tank. If several cars are customarily received at the plant at the same time, it may be well to put in several of these pipes, in which event they should be arranged with 43-foot centers, as this is the length of the most commonly used tank cars. Threaded, or flanged caps, preferably threaded, should be provided for the 10-inch pipes, when not in use. The 4-inch discharge pipes of the car can be located directly over the 10-inch pipe with the result that when the car is properly heated, its contents may be discharged in one-half to three-quarters of an hour.

The 10-inch line should have a gate valve at the entrance to the tank or at the entrance of each tank, if branches are provided to more than one tank. As a matter of safety and also to comply with the insurance rules of some states, the filling pipe should enter the tank near the bottom, thus providing an oil seal which will prevent the possibility of any gas within the tank being ignited by means of a flame carried through the 10-inch line.

It is, of course, necessary to heat heavy oil whenever it is moved. This means that storage tanks may be equipped with heating coils. Where tanks are located above the ground, the area of the heating coils will be largely determined by the climate. Where tanks are buried, approximately 35 ft. of $\frac{3}{4}$ -in. steam pipe should be provided for each 10,000 gallons capacity.

It is quite a common mistake to bring oils to too high temperature when endeavoring to move from storage. This should be avoided because it wastes steam and therefore fuel, unnecessarily, and it does not make oil any easier to handle above a certain point. Should there be any water in the tank, as frequently happens, it may produce steam bubbles in the oil, causing foaming.

A good average safe temperature for handling oil out of storage is 125 deg. F. In laying out steam lines, provision should be made for a $\frac{3}{4}$ -in. line to the tank car.

Best Pump for Oil Service.

Rotary pumps are in use by thousands for handling oil and their popularity is well deserved. The rotary pump has so frequently demonstrated its advantages over the piston pump for this same service, that it is hardly necessary to describe at length the different actions of these two principles. Suffice to say that the rotary pump will handle a larger volume of liquid with less power than the piston pump. This is so because the action of the rotary pump is continuous.

When once started there is no stop or hesitation in the flow of liquid, whereas in reciprocating pumps, when the piston has reached the end of the stroke, it stops and with it stops the flow of liquid. It is a well established fact that it takes more power to intermittently start the movement of anything than it does to keep it moving when once started.

The three advantages of rotary action are: (1) Continuous flow with greater pumping volume; (2) saving in power, with consequent reduced cost of operation; (3) less slippage.

A typical rotary pump is illustrated in Fig. 2. It will be noted that the buckets are hung in the roter in such a way that they ride in the cylinder wall with extremely light contact, similar to a balanced flange valve on a steam engine. An important feature of the action is that the buckets take up their wear automatically, thus making a perfect seat on the cylinder wall at all times. The rotary pump, having a piston suction, need not be primed.

The piston revolves with the shaft, causing the buckets to hold out against the cylinder by centrifugal force and gravity. This exhausts the air from the suction line, allowing the atmospheric pressure to force the oil into the pump and fill the extension chamber. The oil is forced out of the discharge as it cannot carry by the discharge port, owing to the fact that the only oil that will carry by is that which fills the recesses in the piston and this acts as an oil packing, keeping the pump at all times suction tight.

Piping Systems.

Where heavy oil is to be burned as fuel in boilers, special attention must be paid to the design and layout of the piping system between the tank and pumps, and between the pumps and the burners. All of the

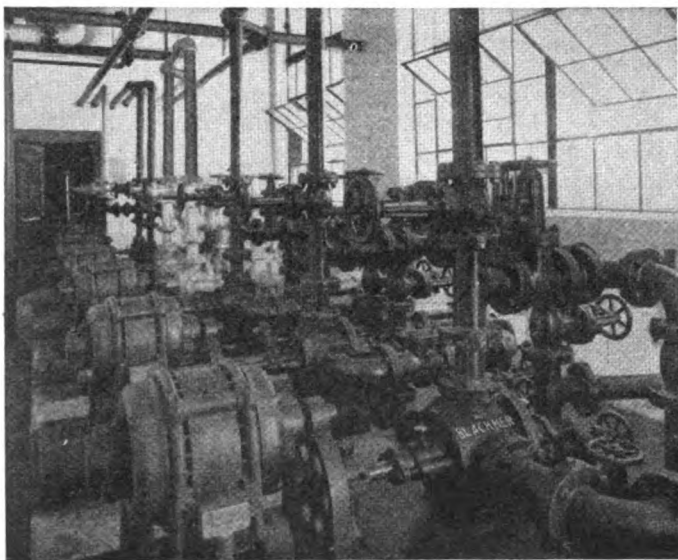


FIG. 3—Pumping plant Standard Oil Company of Ohio. All piping 4-inch. By-pass on every pump.

pumps should be located as close to the tank and at the same time, as close to the floor as possible, in order to reduce friction and suction lifts.

The intake line should be at least half an inch larger than the pump suction. The use of elbows should be avoided, long sweep bends being used in their places. Where the intake pipe lies along level

ground for some distance, it should be installed with a slope upwards of about one floor in 100, toward the pump. Care should be taken to see that pipes are placed either in dry, well drained ground, or in an equally well drained wood or concrete trenches. In the northern states, piping subject to frost should

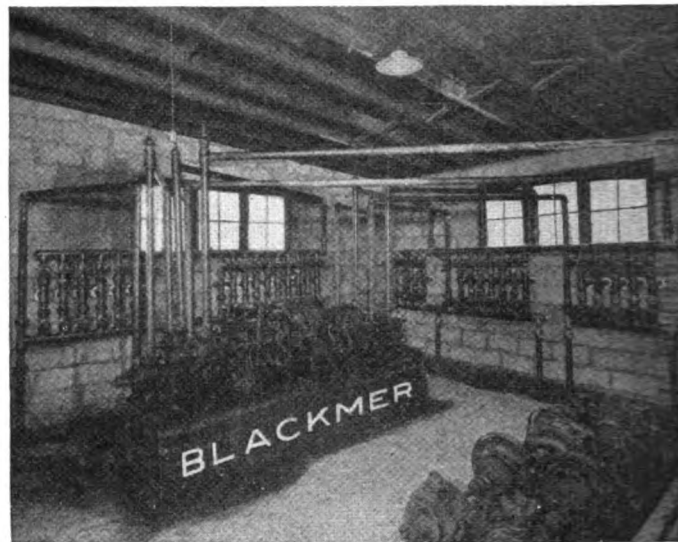


FIG. 4—Pumping plant Nicholas Oil Company, Omaha, Neb., six pumps handle kerosine, gasoline and four grades of lubricating oil. All pumps driven from one motor. Clutches and gears allow operation at any and all units.

be insulated. Discharge pipes from pump to burner should also be insulated.

It is quite frequently the practice to place a small live steam line inside the discharge line to supplement the oil heater. In such cases, expansion at the point where the small line is introduced is taken care of by provision of stuffing boxes. By putting in this small steam line, it is possible to heat the oil in the discharge line when starting up a cold installation. This is an important point as it greatly facilitates handling the heavy oil. Another piping detail which will greatly facilitate handling, is to run a circulating line from the far end of the discharge heater back to the suction tank. This makes it possible to circulate oil entirely through the system, in advance of firing the boilers—quite an advantage with heavy oils.

For piping of this sort, standard weight pipe and fittings can be used. However, real care should be exercised in selecting the valves, as cheap valves have a great tendency to leak.

In putting in piping for oil, joints should be made up with compound not effected by oil. For this purpose a mixture of litharge and glycerine is frequently used. However, to secure best results, this combination should be mixed in very small quantities and used as rapidly as mixed, for the reason that it sets very quickly and is, of course, of little value if the thread is not screwed on and the joint made before the compound has hardened.

Pointers on Efficient Operation.

Oil should not be heated above its flash point in any part of the system except the burner. Such pre-heating will cause oil to become carbonized and to clog up the piping system, resulting in unsteady burning and the need for additional pressure to force oil through the clogged pipes.

TABLE I—RELATIVE VALUE OF COAL AND OIL FUEL

Gross Boiler Efficiency with Oil Fuel	Net Boiler Efficiency* with Oil Fuel	Net Evaporation from and at 212 deg. F. per Pound of Oil	WATER EVAPORATED FROM AND AT 212 DEG. F. PER POUND OF COAL							
			5	6	7	8	9	10	11	12
			POUNDS OF OIL EQUAL TO ONE POUND OF COAL							
73	71	13.54	.3963	.4431	.5170	.5909	.6647	.7386	.8124	.8863
74	72	13.73	.3642	.4370	.5099	.5827	.6556	.7283	.8011	.8740
75	73	13.92	.3592	.4310	.5029	.5747	.6466	.7184	.7903	.8621
76	74	14.11	.3544	.4253	.4961	.5670	.6378	.7087	.7796	.8505
77	75	14.30	.3497	.4196	.4895	.5594	.6294	.6993	.7692	.8392
78	76	14.49	.3451	.4141	.4831	.5521	.6211	.6901	.7591	.8281
79	77	14.68	.3406	.4087	.4768	.5450	.6131	.6812	.7493	.8174
80	78	14.87	.3363	.4035	.4708	.5380	.6053	.6725	.7398	.8070
81	79	15.06	.3320	.3984	.4648	.5312	.5976	.6640	.7304	.7968
82	80	15.25	.3279	.3934	.4590	.5246	.5902	.6557	.7213	.7869
83	81	15.44	.3238	.3886	.4534	.5181	.5829	.6477	.7125	.7772
Net Evaporation from and at 212 deg. F. per Barrel of Oil			BARRELS OF OIL EQUAL TO ONE TON OF COAL							
73	71	4549	2.198	2.638	3.077	3.516	3.955	4.395	4.835	5.275
74	72	4613	2.168	2.601	3.035	3.468	3.902	4.335	4.769	5.202
75	73	4677	2.138	2.565	2.993	3.420	3.848	4.275	4.703	5.131
76	74	4741	2.110	2.532	2.954	3.376	3.798	4.220	4.642	5.063
77	75	4807	2.082	2.498	2.914	3.330	3.746	4.162	4.578	4.994
78	76	4869	2.054	2.465	2.876	3.286	3.697	4.108	4.517	4.929
79	77	4932	2.027	2.433	2.838	3.243	3.649	4.054	4.460	4.865
80	78	4996	2.002	2.402	2.802	3.202	3.602	4.003	4.403	4.803
81	79	5060	1.976	2.371	2.767	3.162	3.557	3.952	4.348	4.743
82	80	5124	1.952	2.342	2.732	3.122	3.513	3.903	4.293	4.683
83	81	5187	1.927	2.313	2.699	3.085	3.470	3.856	4.241	4.627

*Net efficiency = gross efficiency less 2 per cent for steam used in atomizing oil. Heat value of oil = 18,500 Btu.
One ton of coal weighs 2,000 pounds. One barrel of oil weighs 336 pounds. One gallon of oil weighs 8 pounds.

When using a steam atomizing burner see that only enough steam is turned on to give a soft clear flame. Too much steam is not only wasteful, but cools the flame to a certain extent and develops the possibility of blow-torch action so damaging to brick work. A white flame indicates excessive steam. Regulate the steam for each burner at its respective steam valve. Constant attention should be given to this.

If boiler is provided with a superheater see that superheated steam is used in preference to saturated steam as an atomizing agent for the oil.

Oil pressure should not exceed the pressure of the atomizing steam or air. If this occurs there is danger that the oil will lodge on the brick work at the back of the combustion chamber before combustion is complete. In general the steam or air pressure should be five pounds greater than that of the oil.

When a boiler is down for repairs, particularly furnace repairs, take out the burner before any work is done inside. Damage to tips is always possible if the furnace is being worked upon.

Steam From Earth's Center

The idea of obtaining steam power from the heated center of the earth is not practicable at the present time, according to Dr. Thomas T. Read, of the Department of the Interior, who, with F. C. Houghten, of the research laboratory of the American Society of Heating and Ventilating Engineers, has prepared for the Bureau of Mines a report on the cooling of mine air. In descending beneath the surface of the earth the temperature increases continuously with depth at a rate varying from 1 deg. F. for 70 feet in depth to 1 deg. in 250 feet, according to the region where it has been measured. Men have ascended over five miles above the surface of the earth; if they could go five miles below the surface in a shaft that deep a region of high temperature would be reached, and it would seem as though it ought to be possible to utilize that heat as a source of power, free and perpetual. Sir Charles Parsons, the inventor of the steam turbine, has suggested that it is possible, but Dr. Read considers that the difficulties involved would make the

power thus obtained too expensive to compete with coal.

The principal difficulty is not the cost of penetrating to so great a depth (though a shaft 5 miles deep would cost \$5,000,000 or more), but the fact that the amount of heat that can be derived from hot rock is not proportional to its temperature, but is limited by the conductivity of the rock. Comparing the heat with water filtering through porous rock, it is evident that the amount of water that can get through in a given time is not dependent upon the amount of water available, or even on its pressure, but depends chiefly on the porosity of the rock. The heat conductivity of rock is low, and in order to get any considerable quantity of heat through in a unit of time the area of surface exposed must be large.

The second important difficulty depends on space; the heat is available five miles below the surface, but it can only be usefully employed on the surface, and how to get it there without losing most of it on the

way is the problem. One suggestion is to pass water down, and circulate it through large galleries at the bottom, thus giving it time to take up the heat, even at the slow rate of transfer that exists. This would give us water at a high temperature and pressure, but at the bottom of the shaft, where it is no more useful than ice is in the polar regions. In rising to the top of the shaft, the hot water would cool down at about the same rate as it is heated up in descending. Even with extremely efficient (and expensive) heat insulation on the up-going pipe, so much of the heat would be lost that what remained would not pay for the cost of getting it, at least until coal and other sources of power are much more expensive than they are now.

The keeping of a deep mine cool enough so that the miners can work efficiently, which is the subject of Serial 2554 of the Bureau of Mines, written by Messrs. Read and Houghten, is usually made possible by circulating a volume of ventilating air sufficiently large in proportion to the area of workings to be kept cool. In most cases this method will suffice to keep the working places below 85 deg. F. wet bulb, which is about the limit of effective work by the miners. In a series of mathematical calculations that resemble those of Einstein in that very few people can understand them, the authors show why this is so and also why adiabatic compression of the air is so important in deep mines. Air going down into a mine heats up at the rate of $5\frac{1}{2}$ deg. F. for every 1,000 feet of descent from the compression due to the increase in barometric pressure. If this heat is used up in evaporating water in the mine the temperature of the air can be kept down, but if the air on entering the mine is nearly saturated with water vapor the air in the mine gets very hot and the miners can scarcely work. In the deepest mine in the world, in Brazil, the air is dried before it enters the mine and this gives it enough cooling power so the men can work in reasonable comfort in the deepest workings, 6,726 feet below the surface. In most of the mines in the United States, fortunately, the necessary cooling power of the air can be maintained by simply circulating a large enough volume of air, which is much less expensive than drying it.

French exports of iron and steel products during the first 11 months of 1923 were nearly 7 per cent below the amount shipped abroad during the corresponding period of 1922, but were 20 per cent greater than the 1921 period figure. Consignments of French iron and steel and certain manufactures thereof for foreign countries during the calendar year 1923 are estimated at 2,705,300, calculated upon the trade of the first 11 months of the year.

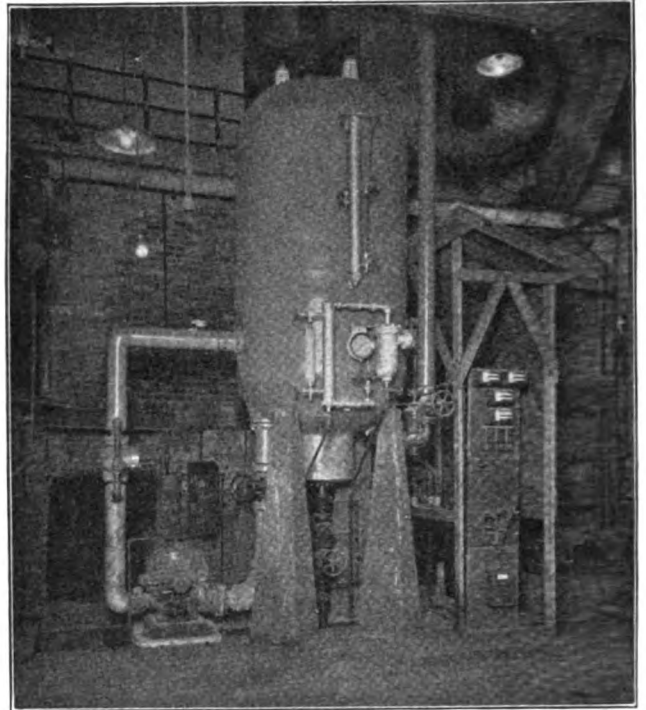
Electric Steam Generator Installation

A recent application of an electric steam generator is the installation of one of these units in the Hudson Falls, N. Y., plant of the Union Bag & Paper Company. This plant is devoted to the manufacture of paper, paper bags and other paper products, and the steam generator recently installed will furnish steam for heating purposes and process work throughout the plant.

The generator was built by the General Electric Company, is rated 5,000 kw., 6600 volt, 500 bhp., and is designed to generate steam at 100 pounds pressure. The generator

operates in parallel with other fuel-fired boilers, but its operation is mostly confined to periods of high water and non-working days, when an excess of water is available for operating the power plant generators. In normal times, the fuel-fired boilers carry the steam load.

In the Hudson Falls plant the operating conditions are such that the steam demand is very constant and the generator, for this reason, is equipped only with hand control. This consists of a valve in the discharge side of the hot water circulating pump. This valve regulates the water level in the



Electric steam generator.

electrode chamber of the generator to such a height as to convert into steam whatever power is available up to the capacity of the generator.

The generator is located in the same room as the fuel-fired boilers and takes up a floor space of approximately 6x10 feet, with a 24-foot headroom for the pump, shell and primary switchboard panel. The unit is operated by the same crew operating the fuel-fired boilers, no increase in boiler room force being necessary.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF

The Blast Furnace and Steel Plant

[Required by Act of Congress of August 24, 1912]

Name of Publication: **The Blast Furnace and Steel Plant**, published monthly at Pittsburgh, Pa. [Report of April, 1924.]

Publisher—The Andresen Co., Inc., 108 Smithfield St., Pittsburgh, Pa.

Editor—F. J. Crolus, 108 Smithfield St., Pittsburgh, Pa.

Managing Editor—L. L. Carson, 108 Smithfield St., Pittsburgh, Pa.

Business Manager—L. L. Carson, 108 Smithfield St., Pittsburgh, Pa.

Names and Addresses of stockholders holding 1 per cent or more of total amount of stock:

L. L. Carson, 108 Smithfield St., Pittsburgh, Pa.

F. C. Andresen, 709 House Bldg., Pittsburgh, Pa.

C. J. Keller, 5840 Solway St., Pittsburgh, Pa.

R. H. Thiess, 426 Byrne Bldg., Los Angeles, Calif.

M. M. Zeder, 108 Smithfield St., Pittsburgh, Pa.

Known bondholders, mortgagees, and other security holders holding 1 per cent or more of total amount of bonds, mortgages, or other securities: None.

L. L. CARSON, Business Manager.

Sworn to and subscribed before me this 20th day of March, 1924.

CHAS. A. SEIBERT, Notary Public.

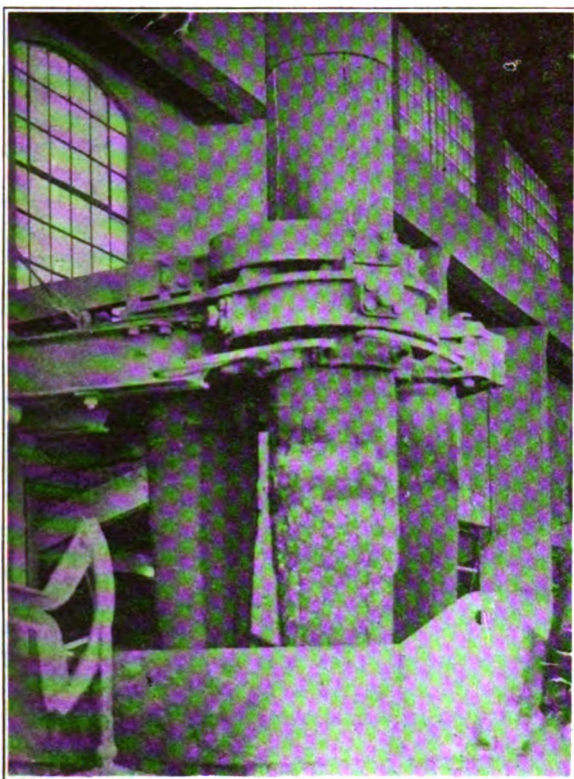
(My commission expires March 6, 1927.)

WITH THE EQUIPMENT MANUFACTURERS

Soderberg Self-Baking Electrode

C. W. Eger, Managing Director of Elektrokemisk Industri, Norway, and connected with numerous Hydro-Power developments and Electro-Chemical industries, is now in the United States with his metallurgical advisor, Dr. M. Sem to negotiate for the use of the Soderberg continuous self-baking electrode.

Mr. Eger reports that licenses for the use of Soderberg electrode and process have been issued to 24 large



companies for use in over 35 different plants. Over 200,000 kw. of carbide, ferro-alloy, iron smelting, aluminum, steel and other furnaces are using or installing the Soderberg electrode.

Mr. Eger or Dr. Sem can be reached through their American representatives, the Electric Furnace Construction Company, 1015 Chestnut St., Philadelphia.

Oil Burner Association Meets

The first annual meeting of the American Association of Oil Burner Manufacturers will be held at the Hotel Chase, St. Louis, April 1, 2 and 3, 1924. A program of speakers of national reputation on both industrial and domestic oil burners has been arranged and the Association has issued a general invitation to firms and individuals in allied industries to attend these meetings. Exhibits of oil burners and oil burning equipment will be shown on the Roof Garden of the Hotel.

The water works pumping station of the City of Allentown, Pa., is described in an illustrated leaflet issued by the De Laval Steam Turbine Company, of Trenton, N. J. The station as a whole may be considered a good example of a reliable and economical plant for a small city. The water supply for the 85,000 inhabitants is taken from two springs, one located near the pumping station and the other at a distance of five miles, and cool, clear and pure water is supplied to 19,000 connections at a single family rate of only \$3.75 net per year. The pressure varies from 40 to 100 lbs., which is sufficient for fire purposes. The principal pumping equipment consists of two centrifugal pumps designed to be driven either by steam turbine or by an electric motor using purchased electric power, the units being mounted upon an elevated platform above flood level, so that the pumps can continue to operate in case the steam supply fails due to flooding of the pumping station.

"Steinmetz and His Discoverer" is the title of a 24 page booklet just published by Robson & Adey, Schenectady. The booklet was written by John T. Broderick, an early associate of Doctor Steinmetz in the General Electric Company, and at present employed there. He is also author of "Pulling Together," a book on industrial relations, containing an introduction by Doctor Steinmetz. Mr. Broderick points to E. Wilbur Rice, Jr., as the discoverer of Steinmetz, and their meeting in a Yonkers workshop 30 years ago is described. An outline of the growth of the electrical industry during the past twenty years follows as a prelude to Mr. Broderick's description of the influence of the two men on electrical progress.

The McConway & Torley Company, Pittsburgh, Pa. is enlarging the boiler room of their steel forging plant at 48th Street and Allegheny Avenue. This plant manufactures the Jenny railroad car coupling. This new addition to the steam plant will include a new 343 horsepower B. & W. boiler and a Westinghouse New Model underfeed stoker. The boiler walls will be protected by non-clinking extension side-wall tuyeres which are fastened to the side of the stoker and extend down along the side wall of the boiler.

This new model underfeed stoker is equipped with an extension agitating grate which is supplied with air under pressure and hence is active fuel burning surface. The agitator is operated by a steam cylinder which may also be equipped for air operation. The depth and contour of the fuel bed on this stoker may be varied at will by means of the secondary ram adjusting mechanisms which are connected to the main fuel feeding rams. The main rams which constitute the fuel feeding mechanisms are driven by a d.c. variable speed motor. A chain transmits the power from the motor to the stoker line shaft which in turn drives the fuel feeding mechanisms.

This new steam unit will use Pittsburgh nut and slack coal of a heating value of approximately 12,500 B.t.u. as fired.

Some Pointers on By-Product Coke Oven Operations

Steam Process Best in Coke Desulphurization

Experimental work on a laboratory scale on the desulphurization of coke by steam, conducted by the Department of the Interior and the Carnegie Institute of Technology at the Pittsburgh Experiment Station of the Bureau of Mines, has demonstrated that the steaming process effects a greater sulphur removal than is possible with other processes. The economic importance of the results of these experiments is that they point the way to future utilization of enormous reserves of high-sulphur coals not now suitable for coke making. At the present time only low-sulphur coals are used for this purpose.

In a report giving the results of these experiments, made by Alfred R. Powell, associate chemist, Bureau of Mines, and John H. Thompson, research fellow, Carnegie Institute of Technology, it is pointed out that sulphur in metallurgical coke gives rise to many problems and difficulties in furnace operations. Over $1\frac{1}{4}$ per cent of sulphur is likely to produce an inferior grade of iron. Sulphur will, in addition to causing trouble in the furnace, make it difficult, if not impossible, to work the iron. Any process for removing this deleterious substance from the coke is therefore of value to both the manufacturer and consumer of coke, if the cost is not prohibitive.

The average annual coke production of the United States during the last 10 years has been 45,404,000 tons. Approximately 60 per cent of this total has been used in metallurgical industries, chiefly iron and steel, while the remainder was consumed for domestic or gas-making purposes. The coal used in producing this quantity of coke represents annually approximately 15 per cent of the total of bituminous coal mined in the United States.

Any saving in the production of coke, even though it be relatively small, or any improvement made in the finished product, will amount to large sums. The removal of part—even a small part—of the sulphur from the coke offers such an improvement. In addition to solving one of the principal problems of the steel industry, this removal would create a much greater coal supply from which the coke producer would draw his raw material. Many of the coals of Pennsylvania, West Virginia, and Kentucky are so high in sulphur that their use for the manufacture of metallurgical coke is prohibitive, without preliminary treatment by the present known means of coal cleaning, principally coal-washing, which is not always an effective remedy. Illinois has the greatest potential coal supply of any State in the Union, with the possible exception of Wyoming, which is underlain by immense fields of low-grade sub-bituminous coal. Nearly all of this Illinois coal will make good coke, if not alone, when used in proper mixtures with other coals; but in most cases the sulphur content is above the limit fixed by present standards. This can not be reduced by washing in some cases, due to the peculiar combinations of the sulphur compounds in the coal. The possibility of removing part of the sulphur should interest the coal mine operator as well as the coke producer; and a new market would be created for the product of the former, which has heretofore only been available to those mining a low-sulphur coal.

Many processes have been tried for the removal of

sulphur from coke, including steam; but most of them have not met with any degree of success. The investigators at the Bureau of Mines laboratories found that between 10 and 15 per cent of the total sulphur in the coke is removed by simple steaming at 75 deg. C. With alternate vacuum and pressure treatment the desulphurization is increased to 20 to 25 per cent. Furthermore it is believed that the steaming is much more beneficial than the actual sulphur reduction indicates, since the sulphur removal is almost entirely taken from the surface of the coke, and this surface sulphur may be the part that is easily absorbed by the iron in the blast furnace.

The recent rapid growth of the by-product coking industry serves to simplify the matter of cheap steam supply. Large quantities of heat are now allowed to go to waste, but this heat could be well utilized in the generation of steam. Thus the process of steam coke could be made comparatively inexpensive.

The investigators point out that, so long as the supply of low-sulphur coals are available, the steaming of coke could not be termed an industrially feasible process. However, when it becomes necessary to resort to the use of higher sulphur coals for the manufacture of coke, the improvement of the coke through steaming may be of sufficient value to warrant the expense of the process. Of the many processes thus far tried, steaming results in the greatest removal, and offers the best possibilities for adaption to the coke industry.

The results of this investigation are embodied in Bulletin 7 of the Coal Mining Investigations Series, which may be obtained from the Carnegie Institute of Technology, Pittsburgh, Pa., at a price of 30 cents.

Bethlehem's Ship Repair Business Increases

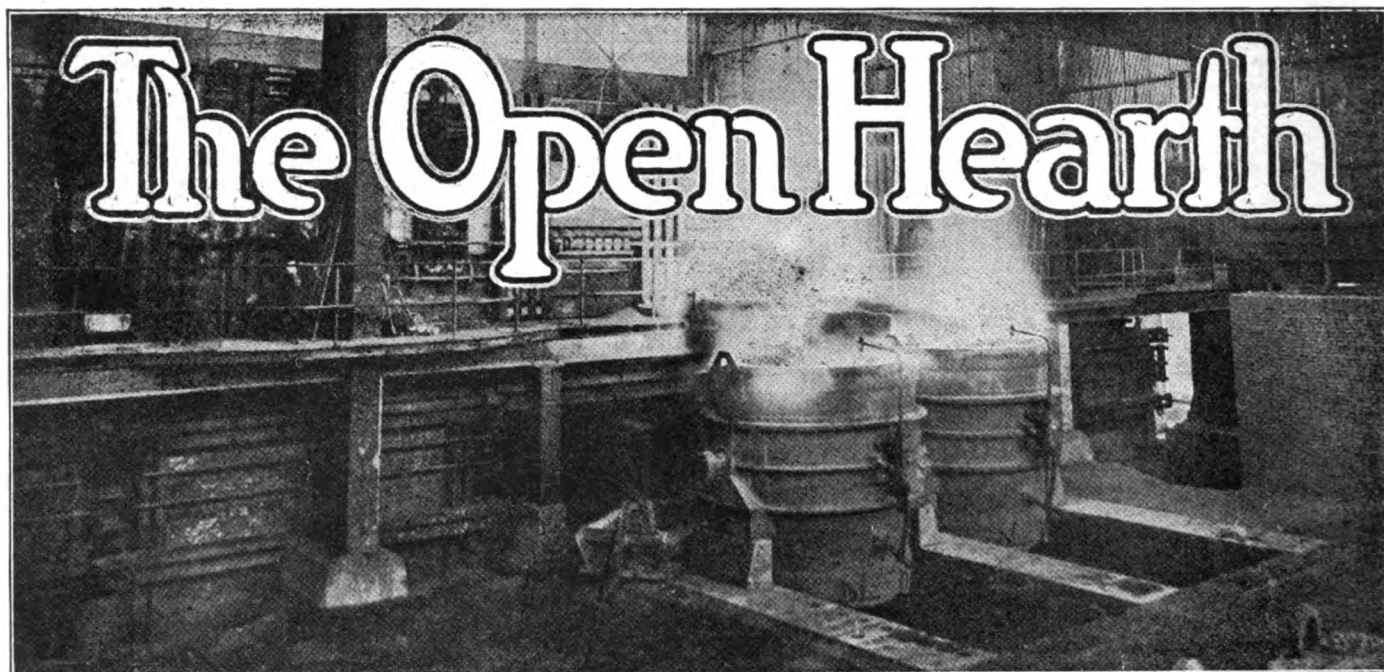
Eugene G. Grace, president of the Bethlehem Shipbuilding Corporation, made public today the following facts regarding the operations of the corporation in 1923:

During the year 1923 the ship repair business of the Bethlehem Shipbuilding Corporation, Ltd., showed an increase over 1922 of 22 per cent in number of ships repaired, of 23 per cent in tonnage of ships repaired and of 25 per cent in billings per ship repaired.

The Bethlehem Shipbuilding Corporation, Ltd., is a subsidiary of the Bethlehem Steel Corporation handling the ship building and ship repairing work of the corporation in addition to constructing passenger railroad cars, American designed Diesel engines, and special machinery for shipping and industrial purposes.

Ship building has declined throughout the world during the past few years. According to a recent statement by Lloyd's register, world ship construction for last year was less than a quarter of that for the record year 1919 when 7,144,000 gross tons of merchant shipping was sent down the ways.

On the other hand, that the old ships are gradually wearing out is indicated by the steady increase in Bethlehem's repair business. The ships repaired by the Bethlehem plants last year were registered at a tonnage of 9,748,872, or equivalent to 59 per cent of the total merchant marine tonnage of the United States.



T. R. Harrison has assumed charge of the Research Department of the Brown Instrument Company. Mr. Harrison was formerly associated with the Pyrometry Department of the Bureau of Standards and more recently with the Champion Porcelain Company of Detroit.

Kent Engineering Company, district representatives of the Conveyors Corporation of America, 326 W. Madison St., Chicago, has changed its address from 504 First National Bank Bldg. to 1110 Farnam St., Omaha, Neb. This engineering firm handles the sale of American Steam Jet Ash Conveyors and American Air Tight Doors, as well as other power plant equipment in Nebraska and Western Iowa.

Inland Steel Company at Indiana Harbor have contracted with Freyn, Brassert & Company for the installation of a Brassert gas washer at their No. 1 furnace. With the completion of this installation the Inland Steel Company will have all of its three furnaces equipped with Brassert washers.

Arthur G. McKee & Company, Cleveland, have been awarded contracts by the National Tube Company, for the design and furnishing of ore and scrap bins, coke bin, 2 scale cars and a McKee Revolving Distributor, all for the No. 1 Blast Furnace of the National Tube Company at McKeesport, Pa.

David O. Stewart has been appointed District Sales Representative for the Ohio Electric & Controller Company, St. Louis, Mo., effective February 15, vice Mr. Thomas E. Beasley, resigned to engage in other business. Mr. Stewart will maintain an office in the Bank of Commerce Building, St. Louis, Mo.

The Belfont Steel & Wire Company, Ironton, Ohio, formed by a merger of the Belfont Iron Works Company and the Kelly Nail & Iron Company, has commenced the erection of an addition to its wire and nail mills to take care of the equipment of the Kelly Nail & Iron Company, which is being moved to the plant of the former Belfont Iron Works Company. The plans of the Belfont Steel & Wire Company include the erection of an open hearth plant and the establishment of a billet and wire mill on the site of the present Kelly nail mills. A pig casting machine at Sarah furnace is also contemplated. Plans are now

being made for blowing in this furnace on Bessemer iron for the company's own use. It is expected that construction work on the units of the plant will be commenced this summer.

President George Gordon Crawford of the Tennessee Coal, Iron & Railroad Company has announced that plans are being worked on for an open hearth plant of four furnaces, and a sheet mill to produce plain and corrugated black galvanized sheets, to be located at Fairfield works, Birmingham, Ala. No estimate was given as to cost nor was any statement made as to when the work will be started.

D. A. Polhemus has resigned as assistant to the president of the Pittsburgh Crucible Steel Company, Pittsburgh, and expects to engage in the construction business at Los Angeles, Cal. Before going with the Pittsburgh Crucible Steel Company, he was with the Carnegie Steel Company at its Clairton, Pa., works.

Rollin K. Cheney, for several years general superintendent of the Sweet's Steel Company, Williamsport, Pa., has resigned that position to accept a similar one with Southern California Iron & Steel Company, Los Angeles, Cal. Mr. Cheney was for several years with the Jones & Laughlin Steel Company (now Corporation), Pittsburgh, being superintendent there of the "double-storage" mills in the South Side plant.

Robert W. Coats, former superintendent for the Sharpsville Furnace Company, Sharpsville, Pa., has accepted the position of superintendent with the Toledo Furnace Company, Toledo, Ohio. J. W. Halloran succeeded Mr. Coats as superintendent at the Sharpsville Furnace Company.

W. L. Reed, superintendent of blast furnace of the Toledo Furnace Company, Toledo, Ohio, resigned March 1.

Decker R. Fithian, formerly general superintendent of sheet mills of Sharon Steel Hoop Company, Youngstown, Ohio, is superintendent of the Waddell Steel Company at Niles, Ohio. Joseph Malborn, formerly assistant general superintendent at Sharon Steel Hoop Company, has succeeded Mr. Fithian as general superintendent of Youngstown, Ohio, plant.

NEWS OF THE PLANTS

The Tidewater Steel Corporation, Baltimore, Md., recently organized with M. D. Perine as president, has acquired a tract of property at Hagerstown, Md., and plans for the construction of a new rolling mill, for which detailed drawings will be prepared at an early date. It is estimated to cost in excess of \$150,000, and will be equipped to give employment to about 300 operatives, with estimated annual output of \$1,225,000 valuation. Arrangements for the new mill will soon be consummated; it is expected to have the plant ready for service during the summer.

The Buffalo Sintering Corporation, Buffalo, N. Y., with headquarters at 86 East Randolph Street, Chicago, Ill., has construction under way on a new plant on Buffalo site for sintering the flue dust from blast furnaces in this district. The new works will be located near the mills of the Donner Steel Company and the Rogers-Brown Company, in the South Buffalo section, and will be equipped with an initial capacity of about 350 tons of sinter per day. All apparatus will be of modern type and will represent a considerable investment. The company is closely associated with the American Sintering Company, with Eugene B. Clark heading both organizations. It is also affiliated with the American Ore Reduction Company, of which Walter S. Reed is vice president and treasurer, occupying the same position with the Buffalo organization.

The Thomas Sheet Steel Company, Youngstown, Ohio, recently organized to take over the former Thomas Sheet Mills of the Youngstown Sheet & Tube Company, located at Niles, Ohio, has secured title to the property and has commenced operations. The plant consists of 12 sheet mills and auxiliary structures, and is expected to be developed to maximum capacity at an early date. It is likely that a number of improvements will be made in the future and additional equipment installed in a number of departments. Charles S. Thomas, heretofore prominent in the DeForest Sheet & Tin Plate Company, Niles, heads the new company and will act as chairman of the board of directors; Myron C. Summers has been elected president; S. P. Ker, Jr., vice president; Claude R. Thomas, treasurer; and Frank Howell, secretary. The last noted has at different times been connected with the American Sheet & Tin Plate Company and the Superior Steel Company.

The Colonial Steel Company, Keystone Building, Pittsburgh, Pa., has completed plans and will commence work at an early date on a new two-story and basement addition to its plant at Colona, Pa., to be used primarily for laboratory service. It is estimated to cost close to \$55,000, including equipment, of which a list will be prepared soon. The general building contract has been awarded to the Cook & Anderson Company, Fifth Street, Beaver, Pa. S. W. Dunlevy is president of the Colonial Company.

The Elyria Iron & Steel Company, 232 East One Hundred Thirty-first Street, Cleveland, Ohio, has plans nearing completion for the erection of a new addition to its plant at Elyria, consisting of four new brick buildings, one of which will be equipped as a rolling mill. The entire plant will represent an investment of about \$400,000, including equipment. Ernest McGeorge, 3020 Euclid Avenue, Cleveland, is architect, and H. B. Wick, president of the Elyria Company.

The Waddell Steel Company, Niles, Ohio, has been organized with a capital of \$600,000, by Jacob D. Waddell and

associates, to take over the former local Enipire plant of the Youngstown Sheet & Tube Company, Youngstown, Ohio, for which arrangements recently were consummated, as announced in these columns in the last issue of The Blast Furnace and Steel Plant. The new organization has started operations and proposes to make a number of improvements in the present plant; four mills are in service and other units will soon be started up. The new company is headed by Jacob D. Waddell, W. H. Davey, A. J. Bentley and others. Mr. Davey is now head of the Mansfield Sheet & Tin Plate Company, Mansfield, Ohio, while Mr. Bentley is president of the Ohio Galvanizing Company, Niles.

The Bethlehem Steel Company, Bethlehem, Pa., has active work in progress on the installation of additional equipment at the blooming mill of its Lackawanna Steel Works, Buffalo, N. Y., all such apparatus to be electrically-operated, and expects to have the unit ready to place in service at an early date. The company also has construction under way on additional coke ovens at this same plant, consisting of two batteries, each with 57 ovens. Work will be pushed for early completion, and operations commenced immediately thereafter. The other departments of the mill are advancing production. There are now seven of the nine blast furnaces in active service, as well as 19 open hearth furnaces on the operating schedule out of a total of 24. All of the plate and other mills are running with normal working forces. The total production is now close to 120,000 tons of ingots per month, as compared with a maximum rating of 135,000 tons. The company is making ready to proceed with improvements and extensions at its Sparrows Point, Baltimore, Md., plant, and expects to install considerable new equipment in the rail mill and other departments of this works, with cost estimated at approximately \$550,000.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, has awarded a contract to the Blaw-Knox Company, Pittsburgh, Pa., for structural steel for the proposed new additions at its local plant, comprising a new sheet mill for the Brier Hill division, with eight hot mills and six cold mills. An order for the rolling mill equipment has been let to the United Engineering & Foundry Company, Pittsburgh, and contracts for miscellaneous auxiliary apparatus will be placed in the near future.

The Columbia Steel Corporation, San Francisco, Cal., with mills at Pittsburg, Cal., and other points on the coast, is completing the construction of blast furnaces at its plant at Iron-ton, Utah, including three stoves and auxiliary departments, and plans to commence active operations at an early date. It is proposed to remove the company offices at Provo, Utah, to Iron-ton, and a new two-story office building will be occupied in the near future. The company has disposed of a bond issue of \$1,000,000, a portion of the proceeds to be used for extensions in properties and general expansion. It is purposed to install new by-product equipment, it is reported, in the months to come.

The Inland Steel Company, Chicago, Ill., is pushing construction on its new open hearth furnaces and blooming mill at the Indiana Harbor works, and expects to have two of the four first noted ready for production in May. The other two furnaces will be ready in June, and will be placed in service immediately thereafter. A new merchant mill is in course of erection, and will likely be completed in about 90 days.

APR 16 1924

The Blast Furnace *(and)* Steel Plant

Member of the Audit
Bureau of Circulations

PITTSBURGH, PA., APRIL, 1924

Entered as second class mail matter at Pittsburgh,
Pa., under the Act of Congress, March 3, 1879.

→ ADAMITE →

“HAVE FAITH”—BELIEVE IN THE BEST

Have Confidence in the:—

GOOD MEN

GOOD MEASURES

GOOD MATERIALS

and in GOOD TIMES

Have Every Confidence in the Future

Your faith in the many men and things that are good must not
be shaken by the failures of a few.

The best men — the best principles — the best in all things will
finally win. Poor substitutes will finally be discarded.

HISTORY WILL REPEAT ITSELF

“HAVE FAITH”

ADAMITE ROLLS AND HEAVY DUTY CASTINGS

Sole Manufacturers { Mackintosh-Hemphill Co. } *Pittsburgh, Pa.*
{ United Engineering & Foundry Co. }